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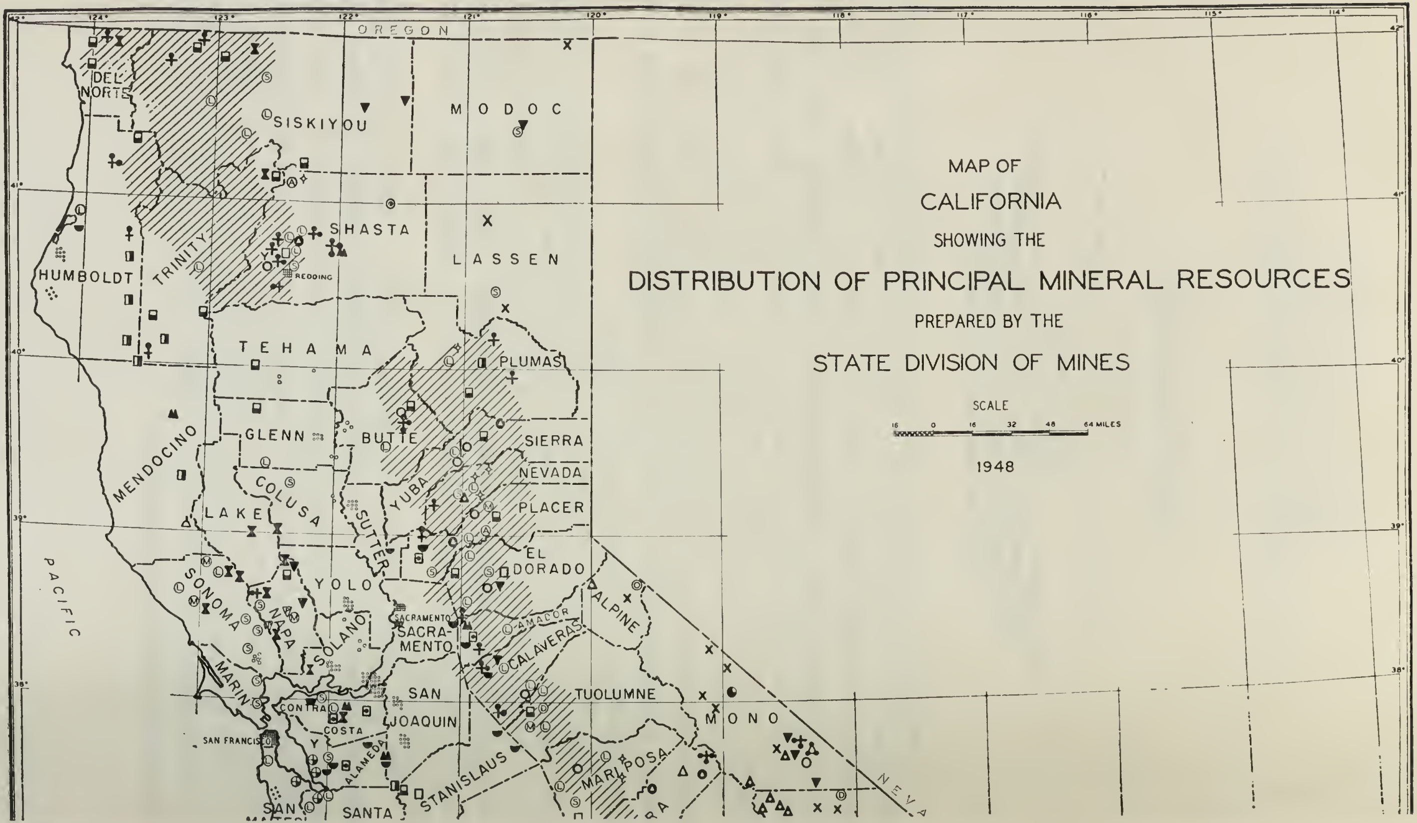

MAP OF
CALIFORNIA
SHOWING THE
DISTRIBUTION OF PRINCIPAL MINERAL RESOURCES
PREPARED BY THE
STATE DIVISION OF MINES

SCALE

1948

16
0
16
32
48
64 MILES
OREGON
DEL NORTE
SISKIYOU
MODOC
HUMBOLDT
TRINITY
SHASTA
REDDING
LASSEN
TEHAMA
PLUMAS
GLENN
BUTTE
SIERRA
NEVADA
MENDOCINO
COLUSA
YUBA
PLACER
LAKE
SUTTER
EL DORADO
SONOMA
YOLO
NAPA
ALPINE
SACRAMENTO
SACRA-MENTO
AMADOR
SOLANO
CALAVERAS
MARIN
TUOLUMNE
SAN JOAQUIN
MONO
CONTRA COSTA
SAN FRANCISCO
ALAMEDA
STANISLAUS
MARIPOSA
SAN MATEO
SANTA
NEVA
PACIFIC
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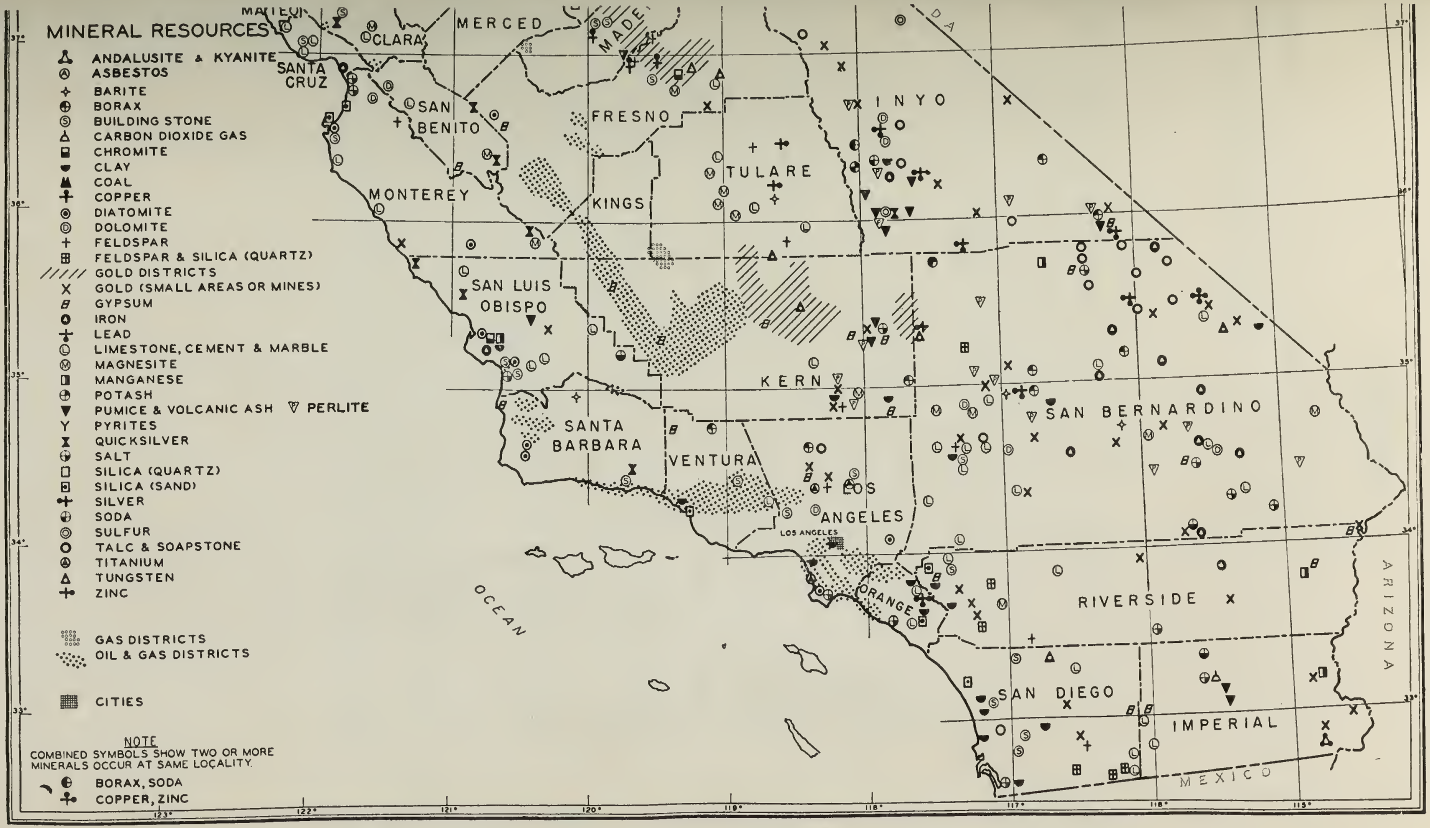
MINERAL RESOURCES
ANDALUSITE & KYANITE
ASBESTOS
BARITE
BORAX
BUILDING STONE
CARBON DIOXIDE GAS
CHROMITE
CLAY
COAL
COPPER
DIATOMITE
DOLOMITE
FELDSPAR
FELDSPAR & SILICA (QUARTZ)
GOLD DISTRICTS
GOLD (SMALL AREAS OR MINES)
GYPSUM
IRON
LEAD
LIMESTONE, CEMENT & MARBLE
MAGNESITE
MANGANESE
POTASH
PUMICE & VOLCANIC ASH
PERLITE
PYRITES
QUICKSILVER
SALT
SILICA (QUARTZ)
SILICA (SAND)
SILVER
SODA
SULFUR
TALC & SOAPSTONE
TITANIUM
TUNGSTEN
ZINC
GAS DISTRICTS
OIL & GAS DISTRICTS
CITIES
NOTE
COMBINED SYMBOLS SHOW TWO OR MORE MINERALS OCCUR AT SAME LOCALITY.
BORAX, SODA
COPPER, ZINC
MATEO
SANTA CRUZ
CLARA
MERCED
MADERA
SAN BENITO
FRESNO
MONTEREY
KINGS
TULARE
INYO
SAN LUIS OBISPO
KERN
SANTA BARBARA
VENTURA
LOS ANGELES
LOS ANGELES
SAN BERNARDINO
ORANGE
RIVERSIDE
SAN DIEGO
IMPERIAL
ARIZONA
MEXICO
OCEAN
DA
37°
36°
35°
34°
33°
123°
122°
121°
120°
119°
118°
117°
116°
115°

CONTENTS

Page

Limestone in the California Beet Sugar Industry, by F. H. Ballou, Jr. 9

Mines and Mineral Resources of Inyo County, by L. A. Norman, Jr. and Richard M. Stewart ---- 17

PLATES

Page

Plate 1. Map of mines and mineral deposits of Inyo County ---- In pocket

2. Map of underground workings, Darwin mines ---- In pocket

3. Photo of mill at Pine Creek mine ---- 80-81

4. *A*, Photo of Darwin mines. *B*, Photo of Darwin Hills ---- 80-81

5. *A*, Photo of west slope of Panamint Range. *B*, Photo of charcoal kilns ---- 80-81

6. *A*, Photo of Pine Creek pendant. *B*, View from Panamint Range ---- 80-81

7. *A*, Photo of Death Valley talc mine. *B*, Photo of truncated alluvial fan ---- 80-81

8. *A*, Photo of Calearth clay deposit. *B*, Photo of New Sutherland Divide Mining Company ---- 80-81

9. *A*, Photo of Reward mine mill. *B*, Photo of Death Valley and Amargosa Range ---- 80-81

10. *A*, Photo of Talc City mine. *B*, Photo of Old Dependable Antimony mine ---- 80-81

11. *A*, Photo of Desert Materials Corporation mining operations. *B*, Photo of Santa Rosa mine ---- 80-81

12. *A*, Photo of Shoshone pumicite "volcanic ash." *B*, Photo of Fish Springs perlite deposit ---- 80-81

13. *A*, Photo of Jamieson pumice pit and screening plant. *B*, Photo showing quarrying of pumiceous perlite ---- 80-81

14. View of southern Coso Range ---- 80-81

15. Photo of Desert Materials Corporation pumice plant ---- 80-81

16. *A*, Photo of pumice beds. *B*, Photo of Independent mine (Cashier) 80-81

17. *A*, Close-up of pumice. *B*, Photo of Black Mountain ---- 80-81

18. *A*, Photo of pumice pit. *B*, Photo of Van Loon "fines" pumice pit ---- 80-81

LIMESTONE IN THE CALIFORNIA BEET SUGAR INDUSTRY

By F. H. Ballou, Jr. *

OUTLINE OF REPORT

	Page
Introduction	9
History	9
Limestone in the non-Steffen factory	10
Limestone in the Steffen factory	14
Reburning of pond lime	15
Suitability of limestone	16

Illustrations

Figure 1. Flow diagram of Dorr continuous carbonation	12
Figure 2. Flow diagram of Steffen process	13

INTRODUCTION

Limestone is used in large quantities by the beet sugar industry. It is a necessary raw material because, although many hundreds of substitute materials and methods have been tried through the years, none has had any measure of success except three allied substances: dolomitic limestone, and the alkaline earths, barium carbonate and strontium carbonate; and these with but little success. There is as yet no economical substitute for limestone in the beet sugar industry.

HISTORY

Napoleon was the father of the beet sugar industry. During the Napoleonic Wars, France was cut off from the West Indian cane sugar by the English blockade. France utilized sugar beets and beet sugar made its first general appearance in the "corner grocery store." Prior to this time (1812) beet sugar had been little more than a laboratory curiosity since its discovery in 1747 by the German chemist, Andreas Margraf.

Some evidence has recently been uncovered by H. W. Dahlberg indicating that the Spanish Padres knew that California Indians made sugar and syrup from wild sugar beets in the Santa Clara valley before 1775.

Although the first United States beet sugar factory was not built in California, one of the first was erected by a coppersmith named Belper in 1856 at Ocean View, now part of the city of San Francisco. These early factories were not successful, however, and the second California factory became the first successful beet sugar factory in the United States. It was built by E. H. Dyer at Alvarado, Alameda County, and operated from 1870 through 1873. It was then moved to Soquel, Santa Cruz County, but ceased operations in 1880.

The third factory was erected at Brighton, Sacramento County in 1871, and the fourth at Isleton, San Joaquin County in 1877. In 1879

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* Engineer, Spreckels Sugar Company, San Francisco, California. Manuscript submitted for publication March 1950.

Mr. Dyer purchased the machinery from the Brighton plant and installed it in the original buildings at Alvarado. Although Alvarado is still in operation it has been rebuilt several times and today is a very modern plant.

Claus Spreckels of San Francisco erected a successful plant at Watsonville, Santa Cruz County in 1889. In 1898 Mr. Spreckels incorporated parts of the Watsonville machinery in the world's largest beet sugar factory at Spreckels, Monterey County.

Many California beet sugar factories have been built and abandoned. California beet sugar factories which were in operation in 1949 are shown in table 1, along with their approximate yearly limestone requirements:

Table 1. California beet sugar factories operating in 1949.

Factory	County	Tons of limestone used per year
*Alvarado	Alameda	12,500
*Spreckels	Monterey	44,000
Hamilton City	Glenn	8,500
Clarksburg	Yolo	12,000
Manteca	San Joaquin	12,000
*Tracy	San Joaquin	17,500
*Oxnard	Ventura	22,000
*Santa Ana	Orange	13,500
Betteravia	Santa Barbara	19,000
*Woodland	Yolo	23,500
Carlton	Imperial	13,500
Total		198,000

* These factories use the Steffen process for recovery of sugar from beet molasses.

LIMESTONE IN THE NON-STEFFEN FACTORY

There are two types of California beet sugar factories: non-Steffen and Steffen. These differ in the quality of limestone required, and in the processing of the limestone and its derivatives.

The non-Steffen factory uses limestone which is 95 percent or more calcium carbonate ($CaCO_3$). It should contain four percent or less magnesium carbonate ($MgCO_3$), which, although not specifically harmful, is less beneficial than $CaCO_3$. Limestone should contain not more than one percent silica (SiO_2), as silica may form gels which hinder filtration of the sugar syrups. As almost all factories have vertical Belgian-type kilns, the limestone pieces should be uniform in size. One size specification in use states that all rock must be screened to 4 inches by 6 inches; another states 2 inches by 4 inches, and still another 4 inches by 8 inches. Although a rock of medium-grain size can be tolerated in a Belgian-type kiln without too much disintegration, a rock of fine-grain size is preferred. Disintegration of the limestone seals off the supply of air, reducing the kiln capacity. It is impossible to burn some limestone in a vertical kiln.

In a non-Steffen house the limestone is burned, or calcined, to give a good slaking test and to produce the maximum amount of calcium oxide (CaO). Metallurgical-grade coke is used as fuel in the Belgian-type kiln. Six to nine pounds of coke is charged into the top of the kiln along with every 100 pounds of rock. In the kiln the limestone is converted into calcium oxide and carbon dioxide gas, and the coke into carbon dioxide gas:

$$CaCO_3 \rightarrow CaO + CO_2 \uparrow$$
$$C + O_2 \rightarrow CO_2 \uparrow$$

Both the quicklime (CaO), and the carbon dioxide gas are recovered from the kiln and used in the process. The CaO is slaked in a rotary drum slaker with either water or "sweetwater"—water containing a small amount of sugar—resulting in calcium hydroxide:

$$CaO + H_2O \rightarrow Ca(OH)_2$$

This in turn dissociates to yield calcium and hydroxyl ions:

$$Ca(OH)_2 \rightarrow Ca^{++} + 2O\overline{H}$$

which is a slurry and is called milk of lime.

The first step in processing sugar beets is called "diffusion." A full explanation of diffusion is outside the scope of this article. However, 95 percent of the sugar in the beets is extracted by the diffusion step as a water solution called "raw beet juice." For each 100 pounds of beets there results about 140 pounds of raw beet juice containing 120 pounds of water, 17½ pounds of sugar, and 2½ pounds of nonsugars. "Nonsugars" is an industry term for all of the constituents other than water and sugar. These nonsugars are regarded as impurities and contaminants. The main function of the beet sugar factory is to separate the sugar from the nonsugars, and every processing step is pointed toward that goal. The resulting sugar produced is so near perfection that the few remaining impurities are measured in parts per million.

Carbonation is the second step in the process, and the step where both products of the limekiln are employed. Several systems of carbonation are in use today. The most common is indicated in figure 1.

In first carbonation, milk of lime is added to the raw beet juice, and carbon dioxide gas is bubbled through the mixture, precipitating the lime as calcium carbonate:

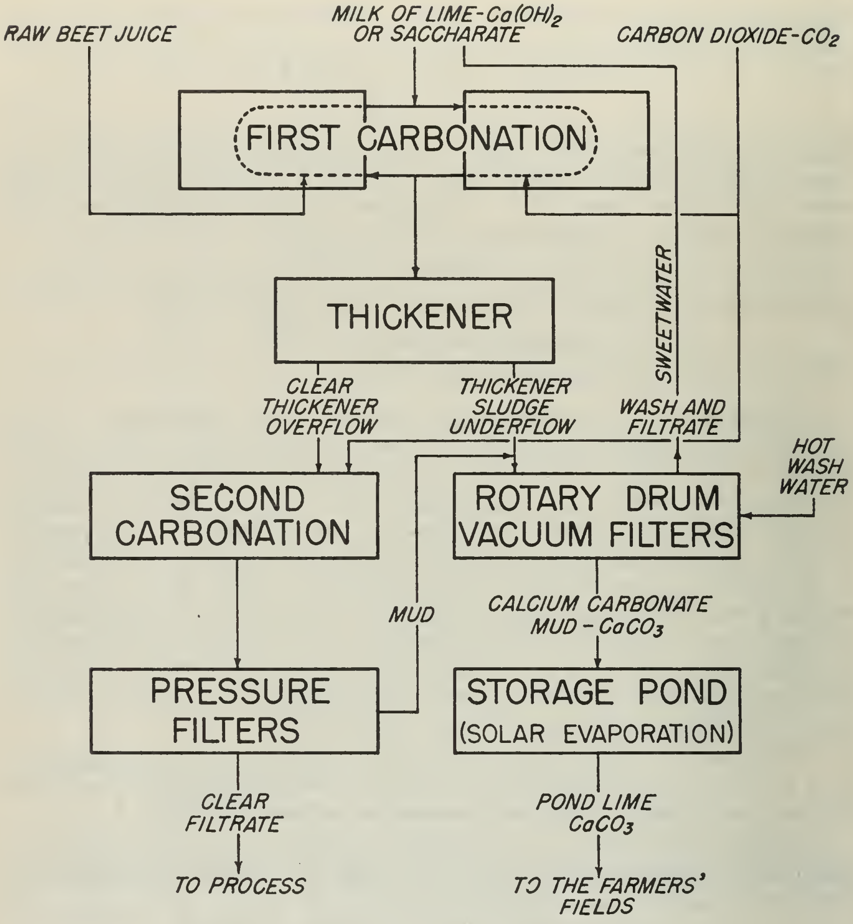
$$Ca^{++} + CO_2 + 2OH \rightarrow CaCO_3 + H_2O$$

The mixture of carbonated juice and calcium carbonate precipitate then flows into a thickener (similar to the thickeners and clarifiers used in the mining industry) which separates it into two fractions: a clear overflow, and a sludge underflow.

More CO_2 gas is bubbled through the clear overflow liquor in second carbonation resulting in a second precipitation of $CaCO_3$. The second carbonation effluent is pumped through pressure filters; the clear filtrate is sent on to process, the $CaCO_3$ cake is added to the thickener underflow.

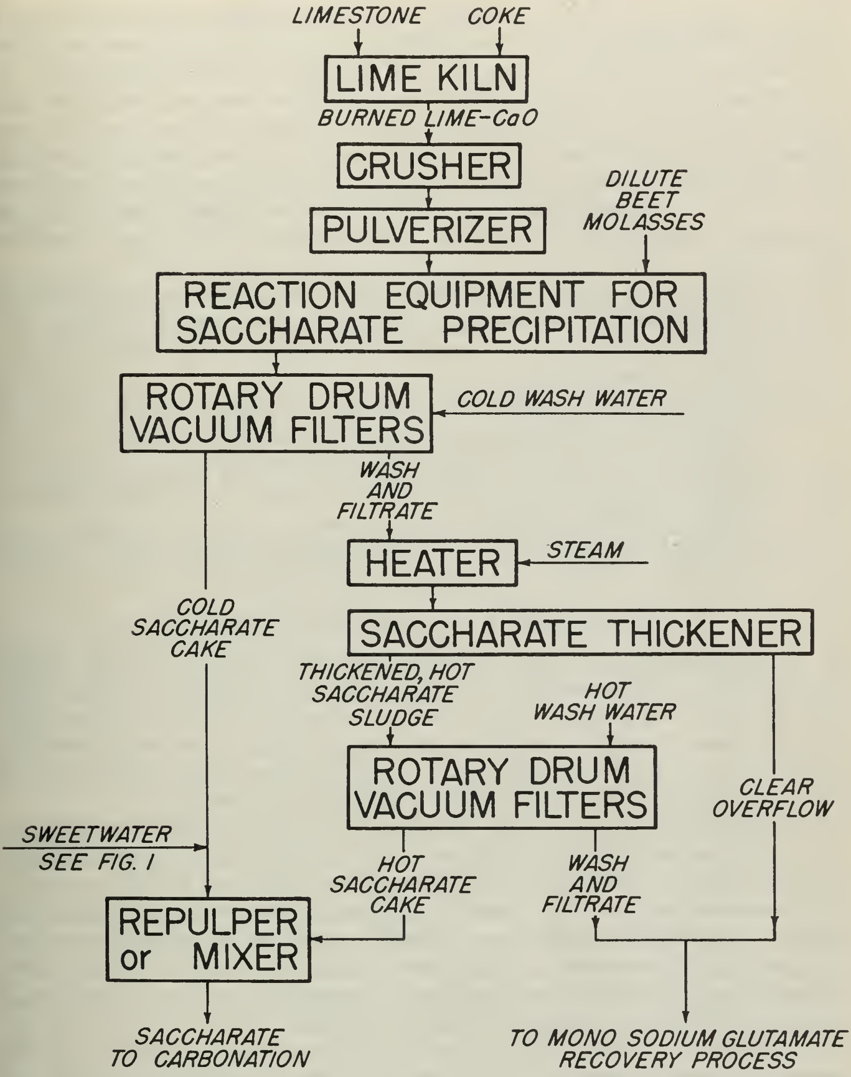
Thickener underflow sludge mixed with pressure filter mud is washed with hot water on rotary drum vacuum filters to remove practically all of the sugar liquor adhering to the precipitated calcium carbonate particles. The wash and filtrate from the vacuum filters therefore contains some sugar and is used to slake the quicklime from the limekiln.

Calcium carbonate mud from the vacuum filters is repulped with water to facilitate pumping to a "lime" pond where it dries by solar evaporation. When sufficiently dry the precipitated calcium carbonate, now called "pond lime," is suitable for use in rehabilitating the farmers'


RAW BEET JUICE
MILK OF LIME-Ca(OH)2 OR SACCHARATE
CARBON DIOXIDE-CO2
FIRST CARBONATION
THICKENER
SWEETWATER
CLEAR THICKENER OVERFLOW
THICKENER SLUDGE UNDERFLOW
WASH AND FILTRATE
HOT WASH WATER
SECOND CARBONATION
ROTARY DRUM VACUUM FILTERS
MUD
CALCIUM CARBONATE MUD - CaCO3
PRESSURE FILTERS
STORAGE POND (SOLAR EVAPORATION)
CLEAR FILTRATE
POND LIME CaCO3
TO PROCESS
TO THE FARMERS' FIELDS

FLOW DIAGRAM OF
DORR CONTINUOUS CARBONATION

FIGURE 1


LIMESTONE
COKE
LIME KILN
BURNED LIME-CaO
CRUSHER
PULVERIZER
DILUTE BEET MOLASSES
REACTION EQUIPMENT FOR SACCHARATE PRECIPITATION
ROTARY DRUM VACUUM FILTERS
COLD WASH WATER
WASH AND FILTRATE
HEATER
STEAM
COLD SACCHARATE CAKE
SACCHARATE THICKENER
THICKENED, HOT SACCHARATE SLUDGE
HOT WASH WATER
ROTARY DRUM VACUUM FILTERS
CLEAR OVERFLOW
SWEETWATER SEE FIG. 1
HOT SACCHARATE CAKE
WASH AND FILTRATE
REPULPER or MIXER
SACCHARATE TO CARBONATION
TO MONO SODIUM GLUTAMATE RECOVERY PROCESS

FLOW DIAGRAM OF
STEFFEN PROCESS

FIGURE 2

fields. A great deal of it is so used. Even so each factory soon builds up a large surplus of pond lime. As pond lime has nearly the same chemical composition as limestone it can be used in place of natural limestone.

It may seem strange that the carbonation process just described should be of such great value. Stated in simplest terms, calcium carbonate is dissociated by heat into CaO and CO_2; then the CaO and CO_2 are recombined back into the original compound, calcium carbonate. The process removes about one-third of the non-sugars from the raw beet juice. It effects both chemical and physical benefits some of which are:

1. Practically all harmful bacteria and fungi that are inherent in plant life and soil are destroyed by the carbonation process.
2. Calcium ions react chemically with some of the non-sugars to form a precipitate.
3. Calcium and hydroxyl ions cause certain non-sugars, such as albumen, to decompose into less harmful compounds.
4. Because of its tremendous surface area, the $CaCO_3$ precipitate attracts and adsorbs colloids and molecules of other non-sugars of high molecular weight.
5. As the precipitate forms it mechanically entraps small fibers and gels which entered carbonation with the juice.

LIMESTONE IN THE STEFFEN FACTORY

Limestone plays a more elaborate and important role in the Steffen factory than it does in the non-Steffen factory. Instead of being slaked upon leaving the limekiln, and then being sent directly to carbonation, it first passes through the Steffen process, and then goes to carbonation, as shown in the flow diagram, figure 2. Limestone so used brings about the recovery of about 97 percent of the sugar in the molasses.

The first difference that appears between the Steffen and non-Steffen factories is in the operation of the limekiln. In the Steffen factory it is necessary to overburn or hard-burn the limestone slightly to obtain the best results. For this reason the limestone must be able to withstand higher temperature and longer retention time in the kiln without disintegrating. This usually means that a limestone suitable for a Steffen factory must have a fine grain size and a low silica content, and that more coke is required to do the calcining or burning.

Rather than being slaked, quicklime from the kiln in the Steffen factory is crushed and pulverized so that 98 percent to 99 percent will pass a 200 mesh screen, and added to a dilute molasses solution. The exact nature of the reaction that then occurs between the powdered quicklime and the sugar in the molasses is not known. We do know that it is dependent upon surface phenomena, and that a precipitate is formed containing about 85 percent of the sugar and 85 percent of the CaO. To obtain good results this exothermic reaction must start at a temperature near freezing and be completed at 55 degrees F. or less. As this is quite cold for a beet-sugar-factory process, and as the precipitate contains the ingredients to make a true lime-sugar compound, or saccharate, the precipitate is called cold saccharate.

This cold saccharate precipitate is filtered off and washed with cold water on rotary drum vacuum filters. Wash and filtrate from the filter contain the remaining 15 percent of sugar and CaO. Upon heating to 85°

C. to 87° C. these combine to form another precipitate; this time a true chemical compound, tricalcium saccharate ($C_{12}H_{19}O_{11}(CaOH)_3 \cdot H_2O$), commonly called hot saccharate.

A thickener is next employed to separate the hot saccharate precipitate in the form of a sludge, suitable for filtration and washing with hot water on rotary drum vacuum filters. Wash and filtrate from the hot saccharate vacuum filter, and clear overflow from the thickener are combined and used as a source of monosodium glutamate.

The cold saccharate and hot saccharate filter cakes are repulped or mixed with ''sweetwater'' and pumped to first carbonation. Hence, in a Steffen factory saccharate milk is added to carbonation in place of the milk of lime used by a non-Steffen factory. In the Steffen carbonation the saccharate milk also dissociates into calcium and hydroxyl ions plus sugar molecules. In the case of the cold saccharate this dissociation is started in the repulper by application of heat. Other than this there are no differences between Steffen and non-Steffen carbonation.

A great many different sugars occur in nature. The word sugar has been used here to mean sucrose ($C_{12}H_{22}O_{11}$), the common sugar of commerce. Identical sucrose sugar is extracted from both the sugar beet and the sugar cane. Sugar beets, like other sugar-producing plants, contain a variety of sugars, including small amounts of dextrose sugar ($C_6H_{12}O_6$); levulose sugar ($C_6H_{12}O_6$), and raffinose sugar ($C_{18}H_{32}O_{16}$). Lime completely decomposes dextrose and levulose sugars into a number of end products having little resemblance to the original sugars. On the other hand raffinose behaves in much the same manner as sucrose when treated with lime.

REBURNING OF POND LIME

It has been known for years that pond lime can be reburned (recalcined) and used successfully in the carbonation and Steffen processes; it is, however, much too fine to reburn in a vertical Belgian-type kiln.

The Spreckels Sugar Company installed two rotary kilns at Spreckels, Monterey County, in 1914. These kilns are still in service. For some years they were used to calcine first carbonation filter-mud directly from the filters. In recent years, however, they have been used to calcine pond lime and are supplying about 25 percent of the Spreckels factory requirements. In 1939 the Holly Sugar Corporation installed a Skinner roaster (multiple-hearth furnace) at their Alvarado, Alameda County factory. Since 1939 this unit has calcined first carbonation filter-mud, ground limestone up to a size of $\frac{3}{8}$-inch, and pond lime. It is at present supplying about 50 percent of the Alvarado factory requirements.

A typical analysis of pond lime is:

	Moisture free basis, percent	*Moisture and organic free basis, percent*
$CaCO_3$	85.41	93.74
$Al_2(PO_4)_3$	2.80	3.07
NaCl and KCl	1.27	1.39
SiO_2	1.02	1.12
$MgCO_3$	0.52	0.57
Al_2O_3 and Fe_2O_3	0.50	0.55
Na_2CO_3	0.16	0.18
Organic and volatile	8.95	
Total	100.63	100.62

SUITABILITY OF LIMESTONE

Limestone for use in the beet sugar industry must be suitable both for the specific kiln in which it is to be burned and for the subsequent processing.

Final determination of the suitability of limestone for burning in a vertical Belgian-type kiln can be made only by a full-scale trial, although an approximation can be made in the laboratory.

Likewise, the suitability of burned limestone for the Steffen process can be determined only by a full-scale factory trial; only indications of the suitability can be gained from laboratory work.

However, the suitability of burned limestone for the non-Steffen factory can usually be determined from the chemical analysis of the rock and supporting laboratory work.

MINES AND MINERAL RESOURCES OF INYO COUNTY †

By L. A. Norman, Jr.* and Richard M. Stewart **

OUTLINE OF REPORT

Page
Abstract 18
Introduction 19
  Geography 19
    Location and accessibility 19
    Topography 20
    Climate 21
    Industries 22
  Geology 22
Mines and mineral resources 28
  Metallic minerals 28
    Antimony 28
    Copper 37
    Gold 38
    Iron 53
    Lead, silver, zinc 55
    Manganese 83
    Molybdenum 84
    Quicksilver 84
    Tungsten 85
  Nonmetallic mineral commodities 98
    Asbestos 98
    Barite 98
    Clay 98
    Feldspar 99
    Fluorite 100
    Garnet 100
    Limestone, including dolomite, marble, onyx marble, and travertine 100
    Mica 103
    Perlite, pumice, pumicite, and volcanic cinders 103
    Sand, gravel, and crushed stone 112
    Slate 112
    Sulphur 112
    Talc 113
    Miscellaneous minerals 127
    Grinding plants 127
  Salines 128
    Borax 128
    Gypsum 128
    Nitrates 129
    Potash 129
    Salt 129
    Soda 129
United States Naval Ordnance Test Station, Inyokern 131
Bibliography 132
Tabulated list of Inyo County mineral deposits 137

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† Manuscript submitted for publication July, 1950.
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** Assistant Mining Geologist, California Division of Mines.

Illustrations

Page
Figure 1. Claim map, U. S. Naval Ordnance Test Station, Inyokern 24
2. Map of underground workings, Davenport mine 42
3. Map of underground workings, Ruth mine 50
4. Flow sheet, Darwin Mines mill, crushing and grinding 61
5. Flow sheet, Darwin Mines mill, flotation 62
6. Flow sheet, Darwin Mines mill, dewatering 63
7. Flow sheet, Shoshone Mines mill, crushing and grinding 65
8. Flow sheet, Shoshone Mines mill, flotation 66
9. Flow sheet, Shoshone Mines mill, dewatering 67

Plate 1. Map of mines and mineral deposits of Inyo County In pocket
2. Map of underground workings, Darwin Mines In pocket
3. Photo of mill at Pine Creek mine 80-81
4. *A*, Photo of Darwin Mines. *B*, Photo of Darwin Hills 80-81
5. *A*, Photo of west slope of Panamint Range. *B*, Photo of charcoal kilns 80-81
6. *A*, Photo of Pine Creek pendant. *B*, View from Panamint Range 80-81
7. *A*, Photo of Death Valley Talc Mine. *B*, Photo of truncated alluvial fan 80-81
8. *A*, Photo of Calearth clay deposit. *B*, Photo of New Sutherland Divide Mining Company 80-81
9. *A*, Photo of Reward mine mill. *B*, Photo of Death Valley and Amargosa Range 80-81
10. *A*, Photo of Talc City mine. *B*, Photo of Old Dependable antimony mine 80-81
11. *A*, Photo of Desert Materials Corporation mining operations. *B*, Photo of Santa Rosa mine 80-81
12. *A*, Photo of Shoshone pumicite "volcanic ash." *B*, Photo of Fish Springs perlite deposit 80-81
13. *A*, Photo of Jamieson pumice pit and screening plant. *B*, Photo showing quarrying of pumiceous perlite 80-81
14. View of southern Coso Range 80-81
15. Photo of Desert Materials Corporation pumice plant 80-81
16. *A*, Photo of pumice beds. *B*, Photo of Independent mine (Cashier) 80-81
17. *A*, Close-up of pumice. *B*, Photo of Black Mountain 80-81
18. *A*, Photo of pumice pit. *B*. Photo of Van Loon "fines" pumice pit 80-81

ABSTRACT

Inyo County, the second largest county in the State, has an area of 10,135 square miles. The topographic extremes of the United States are within its boundaries; Mount Whitney in the Sierra Nevada is the highest, and Badwater in Death Valley the lowest. Of the total land area, 4.15 percent is privately owned and 65.4 percent is federal land. The United States Naval Ordnance Test Station, Inyokern, occupies about 7 percent of the county.

The county, which is almost entirely within the Basin Range geomorphic province, is an area of interior drainage containing a series of northwest-trending mountain ranges separated by troughs and basins. Owens Valley, a tectonic trough, is bounded on the west by the lofty Sierra Nevada and on the east by the Inyo Range, which is built up of a thick, complexly faulted and folded series of sedimentary rocks ranging in age from Lower Cambrian to Triassic. The pre-Tertiary rocks, including pre-Cambrian metasediments and Paleozoic sediments of the Coso, Argus, and Panamint Ranges, total over 45,000 feet in thickness. The Death Valley area contains rocks of all the great time divisions, including more than 30,000 feet of stratified rocks. Some features of the grand-scale faulting in this area are without counterpart in North America.

Detailed geologic maps are being made for the Bishop, Cerro Gordo, and Ubehebe areas.

Inyo County has produced more than 138 million dollars worth of metallic and nonmetallic mineral products since 1880. The copper, gold, lead, silver, and zinc produced has been valued at one-third of this total.

The total recorded gold production from Inyo County between 1880 and 1948 is valued at $11,916,158 and represents the yield of many mines in all parts of the

county. Deposits which are mined chiefly for other metals often contain small but economically important amounts of gold.

The lead, silver, and zinc deposits are among the most important metallic deposits in the county. In most of the deposits, silver and zinc minerals accompany lead minerals; the deposits are typically cavity fillings or replacement bodies in calcareous rocks. The Cerro Gordo district has produced little in recent years. The Darwin and Tecopa districts, since the purchase of the principal mines by the Anaconda Copper Mining Company, have become the major lead-producing areas in the State. The Modoc, Slate Range and Ubehebe districts have also been active recently.

Tungsten production, which has not been recorded separately, probably has a total value approaching that of lead. The Bishop district, from which most of the tungsten has come, is one of the few places in the world where scheelite occurs in commercial quantities in contact-metamorphic deposits. Molybdenum and copper are also being produced from the Pine Creek mine in this district.

Antimony, iron, manganese, and quicksilver have been produced in minor amounts. Copper occurs in many places but is recovered as a by-product only, principally from the Pine Creek mine.

Of the nonmetallic minerals other than the salines, talc is the most important commercially; the total production of talc is valued at $4,406,754. The Talc City area northwest of Darwin is a major source of steatite-grade talc, which is vitally important in the manufacture of high-frequency insulators. This area is in the southern end of the Inyo Range talc belt which extends northward to Eureka Valley. Talc mined in the Southern Death Valley-Kingston Range talc belt, which extends from San Bernardino County into the southern and southeastern portions of Inyo County, is not of steatite grade and is used chiefly in wall tile manufacture.

A large quantity of perlite, pumice, pumicite, and volcanic cinders is produced in the county. These are all products of Cenozoic volcanic activity.

Fuller's earth is being mined from a deposit near Olancha. There are enormous thicknesses of limestone and dolomite, but the utilization of these rocks has been limited to a few deposits. Small amounts of asbestos, feldspar, fluorite, mica, slate, and sulphur have been produced. Garnet for abrasive uses is a by-product of tungsten-milling operations.

Borax and soda products have been the most important of the salines, but the extensive borax deposits have not been worked in recent years. The total borax produced is valued at more than $8,000,000. Soda ash and trona are being recovered from Owens Lake, and the one plant operating also produces some borax. The total value of the soda produced is more than $11,000,000. Neither gypsum nor salt has been produced in recent years, and other salines have been prospected only.

INTRODUCTION[1]

Inyo County, created by an act of the State Legislature in 1866 from parts of adjacent counties, was named after the mountains which border the east side of Owens Valley; the Indian name translated refers to a ''dwelling place of a great spirit.'' Present north and south boundaries were established in 1870 and 1872 respectively, with the east and west boundaries remaining as originally set. Early visitors to the area used a trail established in 1829 by missionary priests. Resting Springs, near Shoshone, was on this route, which crossed the southeastern tip of the county. Joseph R. Walker passed along the east slope of the Sierra Nevada with a party of immigrants in 1843, followed by a Lieutenant Owens of Captain John C. Fremont's troops in 1845.

Geography

Location and Accessibility

Inyo County, 150 miles by road north of Los Angeles along the eastern border of California, is the second largest county in the State. The county contains 10,135 square miles, including 44 square miles of inland waters. It is bounded by Tulare and Fresno Counties on the west, Mono

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[1] Chalfant, W. A., The Story of Inyo, Chalfant Press, revised ed., 1933.
California Blue Book, California Dept. Finance, Sacramento, 1946.

County on the north, and Kern and San Bernardino Counties on the south. Death Valley National Monument, prominent in mining lore and early history of the West, occupies about 2400 square miles in the eastern section of the county. Approximately 75 percent of the Naval Ordnance Test Station, Inyokern, is within the southwestern part of the county. Privately owned land amounts to 4.15 percent of the total area; the rest is land of various political subdivisions. Federal land amounts to 65.4 percent.

Preliminary 1950 census figures show a population of 11,486 in Inyo County, as compared with 7,625 in 1940. Principal centers of population are the Owens Valley area, Darwin, Shoshone, and Tecopa. In the Owens Valley area are the towns of Bishop, Big Pine, Independence—the county seat—Lone Pine, and Keeler. Bishop, near the northern boundary, is the largest town, having 2,858 inhabitants.

Owens Valley is the only part of the county served by rail transportation facilities. A standard-gauge branch line of the Southern Pacific Railroad runs from Mojave, Kern County, to Owenyo, Inyo County. From Owenyo, the railroad continues northward as a narrow-gauge line along the eastern side of the valley to the terminus at Laws; it is standard-gauge size southward from Owenyo to Keeler. The Tonopah and Tidewater Railroad which served the southeastern and Death Valley sections of Inyo County was abandoned in 1940. Paved highways include U. S. Highways 6 and 395 which are coincident through the length of Owens Valley to Bishop; State Highway 190 which runs from Lone Pine to Death Valley Junction, skirting the north shore of Owens Lake and passing through Panamint Valley and Death Valley; and State Highway 127 which enters the county from the south at Ibex Pass and runs northward through Shoshone and Death Valley Junction to Lathrop Well, Nevada on the Las Vegas-Beatty highway. From Bishop, U. S. Highway 6 runs into Nevada through Montgomery Pass at the north end of the White Mountains, and 395 goes through Round Valley and northward into Mono County. Paved highways also serve other parts of Death Valley National Monument and connect with roads to Beatty and Tonopah, Nevada.

The Midland Trail runs eastward from Big Pine to Oasis, Nevada through Westgard Pass in the Inyo Range. The recently improved, partly rerouted, paved road from Trona, San Bernardino County, now affords easier access to Death Valley National Monument via Panamint Valley and Wildrose Canyon and should prove important to southern Argus Range, Slate Range, and Panamint Range mining operations in Inyo County. Many dirt and gravel county roads serve other parts, but large areas of the county remain which are inaccessible by ordinary automotive transportation.

Topography

Inyo County is famous for its topographic extremes. Mount Whitney in the Sierra Nevada, 14,501 feet above sea level, and Badwater in Death Valley, 280 feet below sea level, are the highest and lowest places in the United States. The county, almost entirely within the Basin Range geomorphic province,[2] is an area of interior drainage and contains a series of northwestward-trending mountain ranges separated by troughs and basins. Ten peaks along the crest of the Sierra Nevada in the vicinity of Owens Valley exceed 14,000 feet in altitude. This lofty region of the Sierra Nevada is also the area of its greatest relief; the difference in altitudes between Mount Whitney and the floor of Owens Valley is almost 11,000 feet. Flanking Owens Valley on the east is the Inyo Range, arbitrarily divided by Waucoba Canyon into the White Mountains on the north and the Inyo Mountains to the south.[3] The Inyo Range in Inyo County has altitudes in excess of 11,000 feet and is similar to the Sierra Nevada in ruggedness. Owens River which drains this western section of the county discharges into Owens Lake. About 290,000,000 gallons of water per day is transported from the Owens Valley area through a 250-mile aqueduct to the city of Los Angeles.

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[2] Jenkins, Olaf P., Geologic map of California, Scale 1:500,000: California Div. Mines. 1938.

East of the Inyo Range is the Last Chance Range, the southern extension of which is the Ubehebe Mountains. Between the Ubehebe Mountains and the Inyo Range is Saline Valley, an elliptical depression whose playa is 2500 feet lower than Owens Valley. The Coso Mountains are south of the Inyo Range and separated from it by a flat area, the Darwin Plateau. The Panamint Range crosses the central part of the county in a northwesterly direction from the southern border of the county to the Ubehebe Mountains. The highest point in the range is Telescope Peak, 11,045 feet above sea level. Panamint Valley is bordered by the Panamint Range on the east, by the Argus Range on the west. Between the Panamint Range and the Amargosa Range to the east lies Death Valley, which varies from 5 to 10 miles in width and stretches 90 miles northward from the southern border of the county.

Full but unsatisfactory coverage of Inyo County is provided by the following United States Geological Survey topographic maps: Ivanpah, Furnace Creek, Avawatz Mountains, Lida, Ballarat, and Searles Lake quadrangles, on the scale of 1:250,000, or 1 inch equals about 4 miles, and the Mount Goddard, Bishop, Mount Whitney, and Olancha quadrangles, on the scale of 1:125,000, or one inch equals approximately 2 miles. New maps of several sections of the county are in preparation under a cooperative arrangement between the U. S. Geological Survey and the State of California.

Climate

The diversity of topographic expression in Inyo County results in a diversity of climatic conditions. These conditions range from freezing temperatures in both mountainous and desert areas in the winter months through moderate to extremely high temperatures in the desert sections during the summer season. Summer temperatures of Owens Valley often exceed 100°, with a high of 124° recorded at Independence. The average annual maximum and minimum temperatures at Independence were 71.7° and 43.4° respectively (1865-1930). At Greenland Ranch near Furnace Creek in Death Valley, a temperature of 134° has been recorded, with average annual maximum and minimum temperatures of 90.3° and 60.2° respectively (1911-1930). The lowest temperature recorded here was 15°; the average maximum July temperature was 116.4°. The amount of rainfall also varies within the county, the largest precipitation and snowfall being in the Sierra Nevada. Average annual precipitation at

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[3] Knopf, Adolph, and Kirk, Edwin, A geologic reconnaissance of the Inyo Range and the eastern slope of the southern Sierra Nevada, California, with a section on the stratigraphy of the Inyo Range: U. S. Geol. Survey Prof. Paper 110, p. 17, 1918.

Bishop Creek (altitude 8,390 feet) is 15.42 inches and the average snowfall 134.7 inches (1910-1930). Independence received an average annual rainfall of 4.83 inches (1865-1930); Keeler, 2.98 inches (1885-1909); and Greenland Ranch, 1.45 inches (1911-1930). Snow fell on the floor of Death Valley in January 1949.

Industries

Mining, agriculture, and the tourist-sportsman trade are the principal industries of Inyo County. Mineral production in 1948 amounted to $10,286,796, as compared with $8,134,848 in 1942. Cash income from farms in 1942 amounted to $2,194,000. Electric power is available in ample quantities in the Owens Valley region, as several hydroelectric plants are operated by the Bureau of Water and Power, City of Los Angeles and the California Electric Power Company.

Geology[4]

Large parts of Inyo County are unmapped geologically or have been mapped in reconnaissance only; however, a few small areas have been studied in detail. In recent years, the United States Geological Survey in cooperation with the California Division of Mines has been mapping in detail the lead-silver-zinc deposits of the southern Inyo Mountains and Ubehebe areas, and the tungsten areas near Bishop. The results of statewide commodity investigations of pumice and perlite by Charles W. Chesterman, and of talc by Lauren A. Wright, both of the California Division of Mines, are to be published and will include Inyo County deposits.

Reports of Goodyear,[5] Fairbanks,[6] Spurr[7] and Ball[8] were among the early publications on the geology of Inyo County. A reconnaissance survey of the Inyo Range and the east slope of the Sierra Nevada was made by Knopf and Kirk,[9] and a summary of the geology, mines, and mineral resources of Inyo County was published by Waring and Huguenin[10] in 1919. Saline deposits of the county have been described by Gale.[11] Noble[12] has contributed much by his work in the southern Death

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[4] See the bibliography at the end of this report for many of the published reports on the geology of Inyo County.

[5] Goodyear, W. A., Inyo County: California Min. Bur. Rept. 8, pp. 224-309, 1888.

[6] Fairbanks, Harold W., Preliminary report on the mineral deposits of Inyo, Mono, and Alpine Counties: California Min. Bur. Rept. 12, pp. 472-478, 1894.

[7] Spurr, J. E., Descriptive geology of Nevada south of the fortieth parallel and adjacent portions of California: U. S. Geol. Survey Bull. 208, 229 pp., 1903.

[8] Ball, S. H., A geologic reconnaissance in southwestern Nevada and eastern California: U. S. Geol. Survey Bull. 308, 218 pp., 1907.

[9] Knopf, Adolph, and Kirk, Edwin, op. cit., 1918.

[10] Waring, Clarence A., and Huguenin, Emile, Inyo County: California Min. Bur. Rept. 15, pp. 29-134, 1919.

[11] Gale, H. S., Prospecting for potash in Death Valley, California: U. S. Geol. Survey Bull. 540n, pp. 407-415, 1914.

Gale, H. S., Salt, borax and potash in Saline Valley, Inyo County, California: U. S. Geol. Survey Bull. 540n, pp. 416-421, 1914.

Gale, H. S., Salines in the Owens, Searles, and Panamint basins, southeastern California: U. S. Geol. Survey Bull. 580, pp. 251-323, 1915.

[12] Noble, L. F., Note on a colemanite deposit near Shoshone, California, with a sketch of the geology of a part of Amargosa Valley: U. S. Geol. Survey Bull. 785d, pp. 63-75, 1926.

Noble, L. F., The San Andreas rift and some other active faults in the desert region of southeastern California: Seismol. Soc. Am. Bull., vol. 17, pp. 25-39, 1927.

Noble, L. F., Rock formations of Death Valley, California: Science, vol. 80, no. 2069, pp. 173-178, 1934.

Structural features of the Virgin Springs area, Death Valley, California: Geol. Soc. Am. Bull., vol. 52, pp. 941-1000, 1941.

Valley area. Hazzard [13] and Mason [14] have published the results of their studies in the southeastern part of the county. A strip of territory 67 miles long and 6 miles wide, extending from the crest of the Sierra Nevada to the floor of Death Valley has been mapped by Hopper.[15] More detailed geologic appraisals of some metallic mineral deposits in Inyo County include those of the Darwin silver-lead district by Knopf,[16] Kelley,[17] and Wilson;[18] of the Panamint silver district by Murphy;[19] of the tungsten deposits near Bishop by Lemmon,[20] Bateman and others;[21] of the Coso quicksilver district by Ross and Yates;[22] and of the Wildrose Canyon antimony deposits by White.[23]

The general geology and location of the principal faults in Inyo County are shown on the geologic map of California compiled by Jenkins.[24] Owens Valley, a tectonic trough resulting from subsidence along a series of parallel faults,[25] is flanked on the west by the Sierra Nevada batholith of Upper Jurrasic age. The valley is partly filled with Tertiary and Quaternary sediments and was one of several basins included in an integrated drainage system in Pleistocene time. Glacier-fed streams, draining into Owens Lake, overflowed successively into the lower basins, Indian Wells Valley, Salt Wells Valley, Searles Lake, Panamint Valley, and Death Valley.[26] The Inyo Range, bordering Owens Valley on the east, is composed of a series of thick, complexly folded and faulted sedimentary rocks ranging in age from Cambrian through Triassic, and of Triassic volcanic rocks. The rocks have been intruded by granitic masses related to the Sierra Nevada batholith. Remnants of pre-granitic metamorphic rock crop out in the Sierra Nevada and in places contain tungsten minerals. Tertiary and Quaternary volcanic rocks are distributed in the Owens Valley area and the Coso Range to the south.

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[13] Hazzard, John C., Paleozoic section in the Nopah and Resting Springs Mountains, Inyo County, California: California Div. Mines Rept. 33, pp. 273-339, 1937.

[14] Mason, J. F., Geology of the Tecopa area, southeastern California: Geol. Soc. Am. Bull., vol. 59, pp. 333-352, 1948.

[15] Hopper, Richard H., Geologic sections from the Sierra Nevada to Death Valley, California: Geol. Soc. Am. Bull., vol. 58, pp. 393-432, 1947.

[16] Knopf, Adolph, The Darwin silver-lead mining district, California: U. S. Geol. Survey Bull. 580a, pp. 1-18, 1915.

[17] Kelley, Vincent C., Geology and ore deposits of the Darwin silver-lead mining district, Inyo County, California: California Div. Mines Rept. 34, pp. 503-562, 1938.

[18] Wilson, L. Kenneth, Tungsten deposits of the Darwin Hills, Inyo County, California: Econ. Geol., vol. 38, no. 7, pp. 543-560, 1943.

[19] Murphy, F. M., Geology of a part of the Panamint Range, California: California Div. Mines Rept. 28, pp. 329-356, 1932.

[20] Lemmon, D., Tungsten deposits in the Tungsten Hills, Inyo County, California: U. S. Geol. Survey Bull. 922 q, pp. 497-514, 1941.

Lemmon, D., Tungsten deposits in the Sierra Nevada near Bishop, California: U. S. Geol. Survey Bull. 931 e, pp. 79-104, 1941.

[21] Bateman, Paul C., Pine Creek and Adamson tungsten mines, Inyo County, California: California Div. Mines Rept. 41, pp. 231-249, 1945.

Bateman, Paul C., Erickson, Max P., and Proctor, Paul D., Geology and tungsten deposits of the Tungsten Hills, Inyo County, California: California Jour. Mines and Geol., vol. 46, pp. 23-42, 1950.

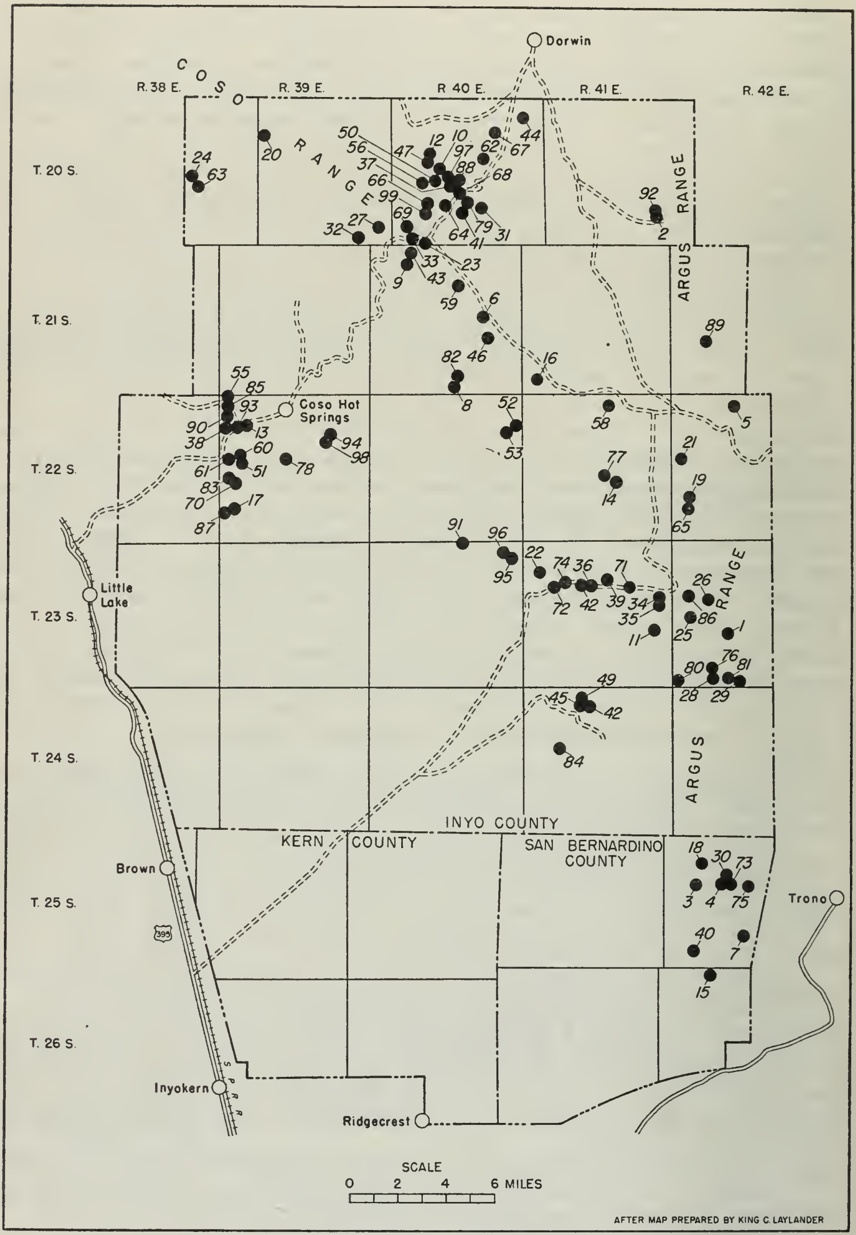
[22] Ross, Clyde P., and Yates, Robert G., The Coso quicksilver district, Inyo County, California: U. S. Geol. Survey Bull. 936 q, pp. 395-416, 1943.

[23] White, D. E., Antimony deposits of the Wildrose Canyon area, Inyo County, California: U. S. Geol. Survey Bull. 922 k, pp. 307-325, 1940.

[24] Jenkins, Olaf P., op. cit., 1938.

[25] Knopf, Adolph, and Kirk, Edwin, op. cit., p. 90, 1918.

[26] Gale, H. S., op. cit., pp. 251-252, 1915.


Dorwin
COSO RANGE
ARGUS RANGE
R. 38 E.
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R. 41 E.
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T. 20 S.
T. 21 S.
T. 22 S.
T. 23 S.
T. 24 S.
T. 25 S.
T. 26 S.
Coso Hot Springs
Little Lake
Brown
395
Inyokern
S P R R
Ridgecrest
Trono
INYO COUNTY
KERN COUNTY
SAN BERNARDINO COUNTY
SCALE
0 2 4 6 MILES
24 63 20 50 56 37 66 99 47 12 10 97 62 44 67 88 68 69 64 79 31 41 27 32 33 23 43 9 59 6 92 2 89 82 46 16 8 55 85 93 90 38 13 60 61 51 78 94 98 83 70 17 87 52 53 58 5 21 77 14 19 65 91 96 95 22 74 36 71 72 42 39 34 35 11 26 86 25 1 80 76 81 28 29 49 45 42 84 18 30 73 3 4 75 40 7 15

AFTER MAP PREPARED BY KING C. LAYLANDER

FIGURE 1. Claim map, U. S. Naval Ordnance Test Station, Inyokern

List of validated claims within U. S. Naval Ordnance Test Station, Inyokern *

Number†	Name of claim	Claimant	Location				County	Mineral product
			Sec.	T.	R.	B. & M.		
1	Alice	Lange, Edith and Wm. J., Wiedow, C. and H. C.	21	23S	42E	MD	Inyo	Gold
2	Argus	Peterson, Theodore	26	20S	41E	MD	Inyo	Gold
3	Argus millsite	Steven, H. G.	17	25S	42E	MD	San Bernardino	—
4	Argus Queen	Steven, Martha L.	16	25S	42E	MD	San Bernardino	Gold, silver
5	Big 4 Iron Nos. 1, 2 and 3	Burton, Nathan	4	22S	42E	MD	Inyo	Iron
6	Big T No. 2	Globerson, M.	14	21S	40E	MD	Inyo	Gold, silver, lead, copper
7	Birds Eye Porphyry	Osborne, Louis R., Steven, Raymond L.	27	25S	42E	MD	San Bernardino	Gold, silver
8	Bonanza	MacConnell	34	21S	40E	MD	Inyo	Gold, silver
9	Bulls Eye and Bulls Eye No. 2	Baggett, V. F.	5	21S	40E	MD	Inyo	Gold, silver
10	Cactus	Freeman, A. B.	17	20S	40E	MD	Inyo	Gold, silver
11	Chloride	Lange, Edith M. and Wm. J., Wiedow, C. and H. C.	24	23S	41E	MD	Inyo	Gold
12	Coso Maid placer	Lorenz, E. M.	17	20S	40E	MD	Inyo	Gold
13	Coso Quicksilver	King, Lloyd W., Leege, A. W., Lynch, L. J.	5–8	22S	39E	MD	Inyo	Quicksilver
14	Danad	Cronin, Dan, Luke, Russell B.	22	22S	41E	MD	Inyo	Zinc
15	Drednaugh	Buckalew, A. H., Jr., Haselbusch, J. W.	4	26S	42E	MD	San Bernardino	Gold, silver, copper
16	Elene	Kerwin, L. J.	31	21S	41E	MD	Inyo	—
17	Elm Nos. 1, 2 and 3	Howard, Horace H.	30	22S	39E	MD	Inyo	?
18	El Oro	Steven, H. G.	8	25S	42E	MD	San Bernardino	Gold, silver
19	El Toro No. 1	Cooper, Phil	30	22S	42E	MD	Inyo	Gold, silver
20	Five Tunnel Nos. 2 and 4	Palmer, A. L., Sims, E. V.	7	20S	39E	MD	Inyo	Gold, silver, copper
21	Gold Bird and Gold Bird No. 1	Schultz, Paul, Estate	18	22S	42E	MD	Inyo	Gold, silver, lead, copper
22	Gold Dollar No. 1	King, Mary A.	7	23S	41E	MD	Inyo	Gold, silver
23	Gold Hill	Wilbur, Fred J.	32	20S	40E	MD	Inyo	Gold
24	Gold King	Smith, W. M.	22	20S	38E	MD	Inyo	Gold, silver
25	Golden Trio Nos. 1 and 2	Lange, Edith M. and Wm. J., Wiedow, C. and H. C.	19	23S	42E	MD	Inyo	Gold
26	Golden Trio millsite	Lange, Edith M. and Wm. J., Wiedow, C. and H. C.	17	23S	42E	MD	Inyo	—
27	Grand View	Urban, Frank, Williams, Roscoe	36	20S	39E	MD	Inyo	Gold, silver, copper
28	Great Divide Nos. 1, 2 and Fraction	Widman, George D.	32	23S	42E	MD	Inyo	Silver, gold, lead
29	Great Divide Extension No. 4	Washmuth, E. C.	33	23S	42E	MD	Inyo	Silver, lead, gold

*List of validated claims within U. S. Naval Ordnance Test Station, Inyokern *—Continued*

Number†	Name of claim	Claimant	Location				County	Mineral product
			Sec.	T.	R.	B. & M.		
30	Great El Oro	Steven, H. G.	16	25S	42E	MD	San Bernardino	Gold
31	Grub Stake	Freeman, A. B.	27	20S	40E	MD	Inyo	Gold, silver
32	Ham and Eggs	Urban, Frank, Williams, Roscoe	35	20S	39E	MD	Inyo	Gold, silver
33	Hortense	Wilbur, Margaret	31	20S	40E	MD	Inyo	Silver, gold
34	Iron Chief	McCord, J. T.	13	23S	41E	MD	Inyo	Iron
35	Iron Mask	Smith, Chester P.	13	23S	41E	MD	Inyo	Iron
36	Jeritza	Smith, Charles R.	9	23S	41E	MD	Inyo	Gold, silver
37	Josephine Millsite	Taylor, Cora (Mrs. O. J.)	21	20S	40E	MD	Inyo	—
38	King Nos. 1 and 2 placers	King, Lloyd W.	7	22S	39E	MD	Inyo	Perlite
39	King Henry	Lange, Edith M. and Wm. J.	10	23S	41E	MD	Inyo	Gold
40	Liberty	Hopkins, Oliver	32	25S	42E	MD	San Bernardino	Gold
41	Liberty Bell	Taylor, Cora (Mrs. O. J.)	28	20S	40E	MD	Inyo	Gold
42	Lost Mine Nos. 1 and 2	Fleming, E. H.	4	24S	41E	MD	Inyo	Gold, silver
43	Luck of the Irish	Wilbur, Fred J.	5	21S	40E	MD	Inyo	Gold, silver
44	Lucky Break	James, C. W.	1	20S	40E	MD	Inyo	Tungsten
45	Lucky Joe	Fleming, E. H.	4	24S	41E	MD	Inyo	Gold, silver
46	Lucky Red Quartz	Chase, W. P., MacDonald, Inez	23	21S	40E	MD	Inyo	Gold, silver, lead
47	Mamie placer	Lorenz, E. M.	17	20S	40E	MD	Inyo	Gold
48	Margarita	Smith, Charles R.	9	23S	41E	MD	Inyo	Gold, silver
49	Marigold and Marigold No. 1	Fleming, E. H.	4	24S	41E	MD	Inyo	Gold, silver
50	Mariposa patent	Hearst and Haggin Estates	20	20S	40E	MD	Inyo	Gold
51	Mary Lee Nos 1, 2, 3 and 4	McElroy, Rossner and Parks	18	22S	39E	MD	Inyo	Perlite
52	Misstake	Hyman, John P.	12	22S	40E	MD	Inyo	Gold, silver
53	Mojave View	Hyman, John P.	12	22S	40E	MD	Inyo	Gold, silver
54	Montezuma No. 1	Wilbur, Paul	20	20S	40E	MD	Inyo	Gold, silver, lead
55	Morning Sun	Thomas, R. M.	6	22S	39E	MD	Inyo	Perlite
56	Mountain Goat	Wilbur, Paul	20	20S	40E	MD	Inyo	Gold, silver
58	New Hope Nos. 3 and 6	Randolph, E. W.	3	22S	41E	MD	Inyo	Gold, silver
59	Ninety Eight (Amd.)	Allen, L. M.	10	21S	40E	MD	Inyo	Gold, silver
60	Noel Nos 1, 2, 3 and 4	Bradley, W. G., Herbert, John, Redmond, N. J., Valkenburgh, W. J.	18	22S	39E	MD	Inyo	Perlite
61	Oak No. 1 and 2	Howard, Horace H., Wolley, Elise G.	18	22S	39E	MD	Inyo	Perlite
62	Old Wrinkle	Murray, V. H., Zager, C. W.	15	20S	40E	MD	Inyo	Gold
63	Orion No. 1	Stewart, John	15	20S	38E	MD	Inyo	Gold, silver, copper
64	Orion No. 1 lode	Ellis, H. R., Ross, Walter W.	28	20S	40E	MD	Inyo	Gold

65	Oro Grande No. 1	Cooper, Phil	30	22S	42E	MD	Inyo	Gold
66	Oro Grande placer	Barrett, Mary H. and Wm. J.	29	20S	40E	MD	Inyo	Gold
67	Panyo No. 1 and 3	Sorenson, Walter J.	11	20S	40E	MD	Inyo	Gold
68	Pathfinder placer	Thorson, Olivera A.	21	20S	40E	MD	Inyo	Gold
69	Pauline	Wilbur, Margaret	31	20S	40E	MD	Inyo	Silver, gold
70	Perlite placer Nos. 1, 2, 3, 4, 5 and 6	Howard, Horace, Wolley, Elise G.	19	22S	39E	MD	Inyo	Perlite
71	Rambler No. 1	Schultz, Paul (Estate)	11	23S	41E	MD	Inyo	Gold, silver
72	Reconstruction	Blewett, Ralph E.	8	23S	41E	MD	Inyo	Gold
73	Red S.	Steven, W. G.	16	25S	42E	MD	San Bernardino	Gold
74	Redwing Nos. 1, 2 and 3	Blewett, Ralph E.	8	23S	41E	MD	Inyo	Gold
75	Royal	Steven, H. G.	15	25S	42E	MD	San Bernardino	Gold
76	Rudy and Rudy No. 2	Widman, Geo. D.	32	23S	42E	MD	Inyo	Gold, silver
77	Russer	Cronin, Dan, Luke, Russell B.	22	22S	41E	MD	Inyo	Zinc
78	Schimpff-Wheeler	Schimpff, Chas. and Wheeler, June	16	22S	39E	MD	Inyo	Gold
79	She Cat	Freeman, A. B.	28	20S	40E	MD	Inyo	Gold, silver
80	Shower of Gold	Widman, George D.	31	23S	42E	MD	Inyo	Gold, silver
81	Silver Gold No. 1 and 2	Lengel, Norma M.	33	23S	42E	MD	Inyo	Silver, lead, gold
82	Silver King No. 1	Globerson, M.	34	21S	40E	MD	Inyo	Gold, silver
83	Star Lite Nos. 1, 2, 3, 4, 5 and 6	Howard, Horace, Wolley, Elise G.	19	22S	39E	MD	Inyo	Perlite
84	Sterling Queen No. 1 and 2	Sterling, L. H. and Ted	17	24S	41E	MD	Inyo	Gold, silver, copper
85	Straight Line Pumice (let-er-be)	Compton, Irma and B. J., Delaney, Gene, Hooper, Roy, Montgomery, W. H., Olson, Harold and Irma, Walker, R. B.	6	22S	39E	MD	Inyo	Perlite
86	Summit	Graves, E. O.	18	23S	42E	MD	Inyo	Gold, silver
87	Sun	Howard, Horace H., Wolley, Elise G.	30	22S	39E	MD	Inyo	Perlite
88	T & T No. 1	Taylor, Cora (Mrs. O. J.)	21	20S	40E	MD	Inyo	Gold
89	Target	Campbell, Wallace, Miley, Joe	20	21S	42E	MD	Inyo	Gold, silver, copper
90	Thomas	Beam, L. Mills, McElroy, Jack, Parks, George	6	22S	39E	MD	Inyo	Perlite
91	Tired Boy	American Pumice Co.	3	23S	40E	MD	Inyo	Pumice
92	Valley View	Peterson, Theo.	26	20S	41E	MD	Inyo	Gold
93	White Duster No. 1 and 2	Howard, Horace H., Wolley, Elise G.	7	22S	39E	MD	Inyo	Perlite
94	White Elephant Nos. 1 and 2	Baird, Irene and W. J., Graves, Lizzie and John, Hopps, Gloria and Mabel, Lillie, John and Sopha S., Schober, Delia	11	22S	39E	MD	Inyo	Pumice
95	White Gold and White Gold Extension	American Pumice Co.	1	23S	40E	MD	Inyo	Pumice
96	White Gold placer (amd.)	American Pumice Co.	1	23S	40E	MD	Inyo	Pumice
97	World Beater No. 1	Buckner, L. H., Oliver, Wm.	21	20S	40E	MD	Inyo	Gold
98	World Beater No. 1 and 2	Hopps, Garfield, Rousey, Leila and Roy N., Schober, Ed., and M. E., Shedd, John, VanNess, C. G.	11	22S	39E	MD	Inyo	Pumice
99	Yankee No. 2	Moore, S. C.	29	20S	40E	MD	Inyo	Tungsten

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* Claims validated as of March 21, 1950 by U. S. Bureau of Land Management and furnished by the Lands Division, U. S. Department of Justice.

† Numbers as used on map, figure 1.

Pre-Tertiary rocks form the bulk of the Argus and Panamint Ranges. Here folded and faulted pre-Cambrian metasediments and Paleozoic dolomites, limestones, shales, and quartzites are associated with Jurassic intrusives.[27] About 5000 feet of Pennsylvanian rocks is exposed in the Darwin Hills, west of the Argus Range.[28] Rocks of all major geologic time divisions from Archean through Quaternary are in the southern Death Valley area, where at least 30,000 feet of stratified rocks are complexly folded and faulted.[29] Of economic importance are the borate deposits in Tertiary lake beds in the region east of Death Valley; here also, are Tertiary volcanic rocks. The mountain ranges and hills in the southeastern part of the county are faulted blocks of pre-Cambrian, Cambrian, and Tertiary formations. This region contains many normal and thrust faults.[30]

MINES AND MINERAL RESOURCES

Mineral production of Inyo County as recorded from 1880 through 1948 was valued at $138,692,011, and consisted of about 40 different metallic and nonmetallic products as shown in table 1. Lead, silver, zinc, gold, tungsten, talc, and salines are the more important ones economically. In recent years, these same minerals, with the exception of salines, have held their position of importance.

The text of the report which follows is grouped into three divisions, metallic minerals, nonmetallic minerals, and salines. Discussion of deposits in the text has been confined largely to those properties active since 1938 or to deposits which have not been described in previous Inyo County reports. The tabulated lists of mines which follow the text include active and inactive properties, with cross-index references to other names by which each property has been known.

Metallic Minerals

Antimony

Antimony minerals have been observed in many places in Inyo County.[31] The deposits in Wildrose Canyon and Trail Canyon in the Panamint Range, those on the west slope of the Argus Range, and one near Bishop on the east slope of the Sierra Nevada have produced small quantities of antimony ore. The most extensive deposits are in the Wildrose Canyon area where stibnite and its alteration products are concentrated in fractures and shear zones along limbs and crests of anticlines in chlorite schist and amphibolite. Near Bishop, pods of stibnite are in a gouge-filled fault zone between rhyolite and limestone. In general, stibnite occurs in veins and fracture zones and in replacement deposits in limestone and shale.

Bishop Antimony Mine.[32] Location: About 3½ airline miles southwest of Bishop in the NE¼ sec. 26, T. 7 S., R. 32 E., M.D.M. on the northeast slope of Coyote Ridge. Ownership: 6 unpatented claims are owned by Mrs. Munsinger, Santa Ana, California (1944).

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[27] Hopper, Richard A., op. cit., pp. 412-413.

[28] Kelley, Vincent C., op. cit., p. 505.

[29] Noble, L. F., op. cit., p. 173, 1934.

[30] Mason, J. F., op. cit., 1948.

[31] Murdoch, Joseph, and Webb, Robert W., Minerals of California: California Div. Mines Bull. 136, pp. 91, 284, 308, 1948.

[32] Tucker, W. Burling, and Sampson, R. J., Current notes on activity in the strategic minerals, Los Angeles Field District, Inyo County: California Div. Mines Rept. 39, pp. 58, 59, 1943.

Pods of stibnite are irregularly distributed in a gouge-filled fault zone which strikes east and dips vertically along the contact of a rhyolite dike in limestone. The zone has an average width of 7 feet. The maximum size of the pods is about 8 feet long and 2½ feet in both width and depth.

The property has a 70-foot vertical shaft and a 175-foot adit connecting on the 60-foot level. All mining has been done on the 60-foot level.

The property was last operated in 1943-44 under lease by R. S. Beatty, Jr., of Huntington Park, California. Four tons of ore was shipped to the Metals Reserve Company. The mill is now leased to the operators of the Yaney mine for the concentration of tungsten ore.

Darwin Antimony Mine. Location: 2 miles north of Darwin in the Darwin Hills; sec. 12, T. 19 S., R. 40 E., M.D.M. Ownership: 3 unpatented claims are owned by F. E. Groover, 1223 Bay Avenue, Balboa, California.

A northward-striking fractured zone in limestone contains stibnite and its alteration products. This mineralized zone dips steeply to the west.

Two inclined shafts, 100 and 168 feet deep, have been sunk on the property, according to the owner. The lower 100-foot shaft is inclined 65° W. and has 50 feet of cross cuts east and west from the shaft bottom. No ore was produced from these workings.

The upper shaft, 365 feet north and 68 feet above the lower one, dips 70° S. 65° W. Lateral workings here consist of 12-foot drifts north and south of the shaft at the 68-foot level and 50-foot drifts north and south of the shaft bottom. From the end of the south drift, one crosscut runs 100 feet west and another 20 feet east. In the latter, the principal ore zone was cut in the footwall of the shaft between the 68-foot and 168-foot levels. A stope in this crosscut produced 50 to 100 tons of ore assaying more than 30 percent antimony.

The property is idle.

Old Dependable Antimony Mine (Transportation). Location: 15 airline miles southwest of Furnace Creek Ranch in Trail Canyon; NE¼ T. 19 S., R. 45 E., M.D.M. (projected). Access by 10½ miles of paved and fair dirt road to the junction of Trail Canyon road and west road of Death Valley, thence 13½ miles westward up Trail Canyon to the mine. Ownership: 16 claims, relocated in 1948 as the Old Dependable Group, are owned by Mrs. B. W. Belyea, 201 Hacienda Drive, Arcadia, California.

The ore, stibnite and its alteration products, is in thin lenses and thicker pods as a replacement in limestone overlain by phyllite and shale. The enclosing rocks trend northward and dip 15°-20° E. near the workings; their dips change rapidly both north and south of the deposit with evident folding and fracturing.

The workings consist of an open cut and two adits. One 11-ton pod of ore, assaying 60 percent antimony was mined from the open cut. The upper adit, which is in the open cut, was driven S. 60° E. for a distance of 50 feet. A 20-foot north lateral is 27 feet from the portal. The undulatory mineralized zone dips steeply at the end of the adit. The lower adit, 100 feet S. 60° W. and 42 feet below the upper adit, runs 70 feet S. 65° E., thence 75 feet N. 85° E.

Table 1. Mineral production of Inyo county, 1880-1948.

A. Metals

Year	Gold	Silver	Lead		Copper		Zinc	
	Value	Value	Pounds	Value	Pounds	Value	Pounds	Value
1880	$48,648	$173,916						
1881	170,000	140,000						
1882	220,000	130,000						
1883	90,000	38,000						
1884	80,000	82,000						
1885	24,998	73,461						
1886	20,156	101,670						
1887	10,649	103,370						
1888	25,000	75,000						
1889	193,957	30,706						
1890	62,432	88,320						
1891	35,466	112,730						
1892	13,930	35,995						
1893	25,945	52,475						
1894	52,639	83,640	900,000	$27,000				
1895	92,142	188,329	1,498,000	46,438				
1896	238,507	108,619	1,220,000	36,600				
1897	159,840	50,063	564,000	19,176				
1898	137,107	73,503	580,000	21,170	49,829	$3,986		
1899	114,187	57,529	662,000	28,135				
1900	213,655	113,483	971,000	38,840				
1901	162,406	56,573	601,000	24,040	8,566	1,349		
1902	74,397	14,484	257,500	9,013	1,100	126		
1903	66,045	18,200	95,000	3,420	23,450	3,098		
1904	150,474	7,122	124,000	5,270	25,508	3,252		
1905	135,959	29,741	345,680	16,247	151,606	23,649		
1906	19,449	13,358	208,018	11,857	4,145	800		
1907	57,241	44,440	261,140	13,096	6,779	1,356	144,213	$8,598
1908	308,873	30,900	683,401	28,244	6 820	938		
1909	457,486	47,117	2,364,137	131,199	39,888	5,073		
1910	408,509	129,590	2,866,227	127,385	58,801	7,489		
1911	574,945	45,678	1,182,122	53,195	27,889	3,486	*	
1912	369,758	45,316	1,207,593	54,342	48,584	8,016	*	

1913	237,310	136,854	3,322,308	146,182	113,860	17,648	7,149,523	449,701
1914	275,000	255,000	4,626,934	180,450	336,423	44,744	399,641	20,381
1915	317,905	127,894	4,323,639	203,211	154,722	27,076	4,625,162	573,520
1916	131,722	232,441	11,185,321	771,787	274,032	67,412	5,758,703	771,666
1917	125,394	534,599	19,318,642	1,661,403	175,273	47,850	3,535,000	359,550
1918	100,240	441,548	12,223,471	867,866	338,518	83,614	2,517,045	229,051
1919	69,560	194,151	3,643,485	193,105	169,713	31,567	1,192,353	87,402
1920	55,634	258,929	4,612,338	368,987	144,286	26,549	[1]	
1921	80,373	86,020	1,052,253	47,351	45,725	5,898	----------	----------
1922	85,265	256,009	6,264,138	344,528	69,537	9,388	[1]	
1923	36,702	265,023	9,541,868	667,931	77,349	11,370	----------	----------
1924	19,997	115,799	4,813,718	385,098	79,995	10,479	----------	----------
1925	43,774	117,763	6,307,105	548,196	73,003	10,367	145,000	11,020
1926	26,871	77,693	6,541,741	523,339	42,462	5,945	76,889	5,767
1927	10,109	47,384	2,173,032	136,901	30,010	3,931	----------	----------
1928	10,781	23,948	1,733,120	100,421	22,250	3,204	----------	----------
1929	16,889	23,209	1,335,831	84,157	17,733	3,121	----------	----------
1930	20,466	42,961	3,452,159	172,608	19,607	2,549	----------	----------
1931	40,603	41,311	3,703,232	137,020	8,542	777	----------	----------
1932	42,113	24,105	2,204,108	66,123	12,672	798	----------	----------
1933	62,312	7,332	601,135	22,241	7,940	508	255,944	10,741
1934	266,109	25,943	530,037	19,611	33,363	2,669	721,719	31,034
1935	656,339	27,621	578,583	23,143	42,589	3,535	274,725	12,088
1936	744,135	39,895	556,399	25,594	57,230	5,265	----------	----------
1937	620,585	78,899	1,908,280	112,589	71,080	8,601	22,364	1,454
1938	625,240	26,581	322,004	14,812	65,844	6,543	----------	----------
1939	443,275	20,434	174,407	8,197	74,543	7,752	7,285	379
1940	415,555	61,623	2,130,330	106,576	212,038	23,960	130,821	8,242
1941	563,360	113,228	6,603,348	376,391	281,211	33,183	438,475	32,886
1942	409,850	237,062	10,170,864	681,448	753,556	91,180	680,422	63,279
1943	153,125	273,706	11,400,763	855,057	973,870	126,603	1,064,722	114,990
1944	89,985	292,269	10,060,151	804,812	557,286	75,234	1,294,165	147,535
1945	64,540	453,604	13,214,935	1,136,484	200,004	27,001	1,297,975	149,267
1946	108,360	783,895	19,124,830	2,084,606	446,386	72,315	2,279,963	278,155
1947	69,090	1,118,578	17,980,000	2,589,120	232,000	48,720	1,404,000	169,884
1948	62,790	518,850	17,240,000	3,085,960	598,000	129,766	9,320,000	1,239,560
Totals	$11,916,158	$9,777,489	241,565,327	$20,247,972	7,265,617	$1,139,740	44,736,109	$4,776,150
Grand total	----------	----------	----------	----------	----------	----------	----------	$138,692,011

B. Nonmetallics

Year	Borax	Soda		Soapstone and Talc		Marble		Miscellaneous and unapportioned		
	Value	Tons	Value	Tons	Value	Cu. ft.	Value	Amount	Value	Substance
1880	-----	-----	-----	-----	-----	-----	-----	-----	-----	
1881	-----	-----	-----	-----	-----	-----	-----	-----	-----	
1882	-----	-----	-----	-----	-----	-----	-----	-----	-----	
1883	-----	-----	-----	-----	-----	-----	-----	-----	-----	
1884	-----	-----	-----	-----	-----	-----	-----	-----	-----	
1885	-----	-----	-----	-----	-----	-----	-----	-----	-----	
1886	-----	-----	-----	-----	-----	-----	-----	-----	-----	
1887	-----	-----	-----	-----	-----	-----	-----	-----	-----	
1888	-----	-----	-----	-----	-----	-----	-----	-----	-----	
1889	-----	-----	-----	-----	-----	-----	-----	-----	-----	
1890	-----	-----	-----	-----	-----	-----	-----	-----	-----	
1891	-----	-----	-----	-----	-----	-----	-----	-----	-----	
1892	-----	-----	-----	-----	-----	-----	-----	-----	-----	
1893	-----	-----	-----	-----	-----	-----	-----	-----	-----	
1894	$81,298	1,530	$20,000	-----	-----	12,500	$62,500	-----	-----	
1895	40,000	1,900	47,500	-----	-----	10,000	50,000	-----	-----	
1896	24,900	3,000	65,000	-----	-----	3,000	24,000	-----	-----	
1897	-----	5,000	110,000	-----	-----	-----	-----	-----	-----	
1898	33,000	7,000	154,000	-----	-----	4,000	12,000	-----	-----	
1899	24,000	10,000	250,000	-----	-----	-----	-----	-----	-----	
1900	13,901	1,000	50,000	-----	-----	-----	-----	20 tons	$700	Antimony
1901	24,250	8,000	400,000	-----	-----	-----	-----	-----	-----	
1902	36,394	7,000	50,000	-----	-----	-----	-----	-----	-----	
1903	26,400	*	*	-----	-----	20,000	20,000	300 tons	2,400	Salt
1904	-----	*	*	-----	-----	3,000	3,000	400 tons	800	Salt
1905	-----	*	*	-----	-----	17,000	17,000	-----	-----	
1906	-----	*	*	-----	-----	1,200	4,800	-----	-----	
1907	*	*	*	-----	-----	1,000	4,000	-----	-----	
1908	*	*	*	-----	-----	-----	-----	-----	-----	
1909	*	*	*	-----	-----	-----	-----	-----	1,417,217	Unapportioned 1900-1909
1910	*	*	*	-----	-----	-----	-----	45,000 tons	31,500	Rubble
1911	*	*	*	-----	-----	-----	-----	46,450 tons	32,555 174	Rubble Gems
1912	*	*	*	1,050	$5,250	-----	-----	-----	648	Rubble
1913	*	*	*	1,000	4,400	3,200	11,500	13,500 tons	54,000 835	Salt Rubble
1914	*	*	*	390	2,060	3,500	10,500	13,500 tons	54,000	Salt
					[1]Totals	78,400	$219,300			

Year	Borax	Soda		Soapstone and Talc		Miscellaneous stone[1]	Miscellaneous and unapportioned		
	Value	Tons	Value	Tons	Value	Value	Amount	Value	Substance
1915	*$8,162,727	*112,937	*$496,250	1,513	$14,000	----	----	$80,430	Antimony, dolomite, marble, pumice, salt
1916	[1]	10,593	264,825	685	4,606	$23,040	3,596 tons	14,700	Dolomite
							----	2,317,897	Other minerals[2]
1917	[1]	19,604	861,160	4,736	41,044	3,000	11,315 tons	22,630	Dolomite
							----	2,639,600	Other minerals[3]
1918	[1]	[1]	----	9,635	72,549	5,000	14,390 tons	32,056	Dolomite
							589 tons	854,025	Tungsten concentrates
							----	2,491,727	Borax, limestone, salt, soda
1919	[1]	[1]	----	[1]	----	7,850	2,360 tons	12,000	Limestone
							----	2,097,271	Other minerals[4]
1920	----	23,132	933,023	[1]	----	1,190	15,240 tons	31,080	Limestone
							----	2,214,008	Other minerals[5]
1921	----	[1]	----	4,350	77,250	16,250	22,112 tons	49,073	Dolomite
							1,185 tons	8,295	Fuller's earth
							----	1,089,708	Other minerals[6]
1922	[1]	[1]	----	[1]	----	12,000	43,778 tons	72,284	Dolomite
							----	1,358,207	Other minerals[7]
1923	[1]	24,116	662,747	5,981	104,976	19,500	47,542 tons	79,793	Dolomite
							----	997,539	Other minerals[8]
1924	[1]	[1]	----	5,942	98,806	12,500	17,197 tons	37,491	Dolomite
							----	1,429,925	Other minerals[9]
1925	[1]	[1]	----	5,335	89,134	----	----	1,764,891	Other minerals[10]
1926	[1]	60,473	1,232,081	6,487	98,563	12,000	2,275 tons	20,130	Fuller's earth
							300 tons	1,750	Pumice
							----	831,695	Other minerals[11]
1927	[1]	53,328	1,293,379	7,009	99,416	6,000	344 tons	2,946	Pumice
							----	920,218	Other minerals[12]
1928	[1]	86,664	1,292,165	8,563	121,177	44,831	163 tons	1,630	Pumice and volcanic ash
							----	234,410	Other minerals[13]
1929	[1]	70,440	1,525,060	8,274	120,875	224,625	----	298,275	Other minerals[14]
1930	[1]	67,119	1,273,098	[1]	----	310,675	----	438,409	Other minerals[15]
1931	[1]	56,251	903,511	[1]	----	[1]	----	224,486	Other minerals[16]
1932	[1]	[1]	----	[1]	----	5,800	431 tons	4,845	Pumice and volcanic ash
							----	580,237	Other minerals[17]

B. Nonmetallics—Continued

Year	Borax	Soda		Soapstone and Talc		Miscellaneous stone[1]	Miscellaneous and unapportioned		
	Value	Tons	Value	Tons	Value	Value	Amount	Value	Substance
1933	1	1	-----	1	-----	18,690	48,487 tons	164,987	Dolomite
							894 tons	4,150	Pumice and volcanic ash
							-----	724,346	Other minerals[18]
1934	1	1	-----	1	-----	66,081	673 tons	5,115	Pumice and volcanic ash
							-----	877,163	Other minerals[19]
1935	1	1	-----	1	-----	1	594 tons	10,034	Pumice and volcanic ash
							-----	827,046	Other minerals[20]
1936	1	1	-----	1	-----	1	1,567 tons	18,492	Pumice and volcanic ash
							-----	633,466	Other minerals[21]
1937	1	1	-----	1	-----	22,087	2,721 tons	29,518	Pumice and volcanic ash
							-----	565,276	Other minerals[22]
1938	1	1	-----	18,581	194,588	32,026	2,061 tons	19,922	Pumice and volcanic ash
							-----	664,271	Other minerals[23]
1939	1	1	-----	1	-----	4,230	5,886 tons	56,170	Pumice
							-----	1,074,160	Other minerals[24]
1940	1	1	-----	1	-----	41,579	3,974 tons	20,690	Pumice
							64,882 units	1,440,889	Tungsten ore
							-----	736,592	Other minerals[25]
1941	1	1	-----	20,003	255,775	25,090	117,166 units	2,868,870	Tungsten ore
							-----	751,243	Other minerals[26]
1942	1	1	-----	29,000	356,345	171,559	-----	6,124,125	Other minerals[27]
1943	1	1	-----	29,614	401,745	5,870	213,700 units	4,841,322	Tungsten ore
							-----	1,252,988	Other minerals[28]
1944	1	1	-----	24,505	356,108	11,462	12,956 tons	72,996	Pumice
							-----	4,841,102	Other minerals[29]
1945	1	1	-----	28,991	457,447	36,262	-----	1,933,645	Other minerals[30]
1946	1	1	-----	28,076	477,037	18,312	8,496 tons	73,173	Pumice
							-----	2,322,686	Other minerals[31]
1947	1	1	-----	30,444	482,007	1	-----	2,119,069	Other minerals[32]
1948	1	1	-----	33,546	471,596	1	-----	4,778,274	Other minerals[33]
Totals	$8,466,870	629,087	$11,883,799	313,710	$4,406,754	$1,157,509	-----	$64,700,270	

* Combined to conceal individual annual output.

[1] See under 'Unapportioned.'

[2] Includes antimony, borax, gypsum, marble, molybdenum, salt, tungsten.

[3] Includes asbestos, barytes, borax, gypsum, marble, molybdenum.

[4] Includes borax, dolomite, marble, pumice, salt, soda, talc, tungsten.

[5] Includes borax, dolomite, fuller's earth, marble, volcanic ash, salt, talc, zinc.

[6] Includes borax, building stone, marble, pumice, soda.

[7] Includes borax, building stone, clay (pottery), fuller's earth, limestone, marble, pumice, soda, talc, zinc.

[8] Includes building stone, borates, fuller's earth, gems, marble, pumice, tungsten concentrates.

[9] Includes alum, borates, building stone (tuff), fuller's earth, glauber salt, lime, limestone, magnesium sulphate, pumice, radio galena crystals, soda (ash and bicarbonate), tungsten concentrates.

[10] Includes borates, building stone (tuff), fuller's earth, graphite, limestone, pumice, soda (ash and bicarbonate), tungsten concentrates.

[11] Includes borates, building stone (tuff), dolomite, gems, limestone, salt, tungsten concentrates.

[12] Includes borates, building stone (tuff), dolomite, fuller's earth, lime.

[13] Includes borates, dolomite, fuller's earth, gems, granite (tuff), salt, tungsten.

[14] Includes borates, dolomite, fuller's earth, gems, granite (tuff), limestone, marble, pumice, salt, tungsten.

[15] Includes barytes, bentonite, borates, dolomite, gems, granite (tuff), lime, marble, mineral water, pumice, salt, silica, talc, tungsten.

[16] Includes barytes, bentonite, borates, dolomite, lime, limestone, pumice, quicksilver, talc, miscellaneous stone.

[17] Includes bentonite, borates, dolomite, feldspar, quicksilver, silica, slate, talc, soda, sulphur.

[18] Includes bentonite, borates, pottery clay, molybdenite, silica, slate, talc, soda, sulphur, tungsten.

[19] Includes bentonite, borates, dolomite, gems, slate, soda, sulphur, talc.

[20] Includes bentonite, borates, dolomite, quicksilver, slate, talc, soda, sulphur, miscellaneous stone.

[21] Includes bentonite, borates, dolomite, onyx, quicksilver, talc, soda, miscellaneous stone, sulphur, tungsten, slate.

[22] Includes bentonite, borates, dolomite, iron ore, quicksilver, slate, soda, sulphur, talc, and tungsten ore.

[23] Includes borates, dolomite, garnet, iron ore, limestone, onyx, quicksilver, slate, soda, sulphur, tungsten ore.

[24] Includes antimony, bentonite, borates, dolomite, garnet, iron ore, lime, limestone, marble, molybdenum ore, quicksilver, soda, sulphur, talc, tungsten ore.

[25] Includes antimony, bentonite, borates, dolomite, iron ore, limestone, mica schist, molybdenum ore, quicksilver, soda, sulphur, talc.

[26] Includes antimony, asbestos, bentonite, borates, dolomite, iron ore, limestone, mica schist, molybdenum ore, pumice, soda, sulphur.

[27] Includes antimony, bentonite, borates, dolomite, iron ore, limestone, molybdenum ore, pumice, quicksilver, salt, soda, sulphur, tungsten ore.

[28] Includes borates, limestone, manganese ore, molybdenum ore, pumice, quicksilver, soda.

[29] Includes antimony, bentonite, borates, limestone, marble, molybdenum ore, pumice, quicksilver, soda, tungsten ore.

[30] Includes bentonite, borates, garnet, limestone, molybdenum, pumice, soda, tungsten ore.

[31] Includes bentonite, borates, dolomite, limestone, molybdenum ore, soda, sulphur, tungsten ore.

[32] Includes borates, raw clay, diatomite, fuller's earth, molybdenum, pumice and pumicite, sodium salts, stone, sulphur ore, tungsten concentrates.

[33] Includes antimony ore, boron minerals, raw clay, diatomite, fuller's earth, molybdenum, pumice and pumicite, sand and gravel, slate, sodium salts, stone, sulphur ore, tungsten concentrates.

Brinn W. Belyea, operator during the period 1939-1941, produced approximately 70 tons of ore, ranging from 18 to 60 percent antimony. Approximately $50,000 was spent during that period in road building, constructing camp facilities, and mining operations, according to R. L. Jordan. J. W. E. McCulley, Darwin, obtained a bond and lease on the property in January 1949. The Trail Canyon road to the property was rebuilt and mining was started in April 1949. He reported that two cars of ore mined from the open cut were not shipped because of poor market conditions existing in June 1949.

The property is idle.

Wildrose Antimony Mines[33] *(Monarch, Combination, Monopoly, and Kennedy Claims)*. Location: 7 miles northwest of Telescope Peak on the west slope of the Panamint Range. Ownership: The Monarch, Combination and Monopoly group of patented claims on the south side of Wildrose Canyon and the Kennedy patented claim on the north side of the canyon are owned by James C. Davis, 2944 The Mall, Los Angeles 23, California, Andrew G. Barnes Estate, A. C. McLure Estate and Ruth F. Bastanchury, the latter three in care of Mrs. G. A. Bastanchury, Box 25, Pittman, Nevada.

Initial work on the deposits was done before 1894,[34] with greatest activity recorded in the period 1915-17. Western Metals Company is reported by Tucker and Sampson[35] to have produced 4000 tons of ore containing 32 percent antimony during this period; White[36] estimates a production of less than 1000 tons of metallic antimony in the same period. Some of the ore was treated at a concentrating plant in Wildrose Canyon, although most of it was shipped to the company smelter at San Pedro. A small amount of ore shipped during 1937-38 marks the only activity since 1918. Much of the production has been from the Monarch claim.

The antimony deposits are mostly in fracture and shear zones along the limbs and crests of anticlines in chlorite schist and amphibolite. The Kennedy claim deposit is a fissure filling along a small fault. Primary minerals are quartz, stibnite, pyrite and fluorite; the oxidation products include gypsum, oxides of antimony, and jarosite. White[37] estimates that most of the reserves consist of ore containing less than 5 percent antimony, although the deposits contain high-grade pods and pockets which could be hand-picked to produce at least 40 percent ore. The ore mined in the period 1915-17 was from such pods and pockets.

Detailed descriptions of the deposits and mine workings are summarized from White's report.[38]

Monarch deposit, also known as the Wildrose Antimony Mine, has been worked by several adits and an open cut. The lower, or haulage adit, contains 200 feet of workings with few visible antimony minerals. High-grade lenses of stibnite and quartz were found in the open cut 25 feet above the lower adit.

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[33] White, Donald E., Antimony deposits of the Wildrose Canyon area, Inyo County, California: U. S. Geol. Survey Bull. 922k, 1940.

[34] Crawford, J. J., California Min. Bur. Rept. 12, p. 21, 1894.

[35] Tucker, W. B., and Sampson, R. J., Mineral resources of Inyo County, California: California Div. Mines Rept. 34, p. 378, 1938.

[36] White, Donald E., op. cit., p. 308.

[37] White, Donald E., op. cit., p. 316.

[38] White, Donald E., op. cit., pp. 320-324.

The Monarch and Combination mines exploit a vein system which extends southward along Antimony Ridge for 1200 feet. Veins range from a few inches to 5 feet in width, averaging 1½ feet. Three shafts, the deepest 50 feet, have been sunk on the main vein; 35 feet west of the central part of the main vein a 70-foot shaft has been sunk on the intersection of a short vein and fracture zone. The ore deposit of the Monopoly claim is confined to an area about 100 feet square in which there are lenses of high-grade antimony.

The main Kennedy vein strikes N. 10° W., dips 70° E. and can be traced for a distance of 200 feet. Three short adits expose a vein averaging two feet in thickness in the area of the adits.

The property is idle.

Copper

Deposits containing copper minerals occur in many places in Inyo County, but copper is recovered only as a by-product. The largest amount now comes from the Pine Creek tungsten mine in the Bishop area. Here chalcopyrite and bornite are associated with the tungsten and molybdenum ore bodies. The ore milled has been 0.20 to 0.25 percent copper.[39] Copper is also a by-product of the lead-silver-zinc mines in the Darwin and Tecopa districts.

In recent years practically the only property worked specifically for copper ore has been the Sally Ann mine in the Ubehebe district.

For descriptions of the copper deposits in the Darwin, Greenwater, and Ubehebe districts, see earlier publications of the Division of Mines.[40]

Sally Ann Mine. Location: 23 airline miles northeast of Keeler on the west slope of an unnamed range of mountains east of the Racetrack playa in the Ubehebe mining district; SW¼ of the SW¼ T. 14 S., R. 41 E., M.D.M. (projected). Access is by poor dirt road, 25 miles south of Ubehebe Craters. Ownership: 5 lode claims, Sally Ann No. 1-5 inclusive, are owned by James Arnold, Orval Huffman and Sally Ann Smith of Compton, California.

Copper minerals are found along the contact of quartz monzonite and a Paleozoic metamorphic roof pendent.[41] Oxidized copper minerals are most abundant in areas of skarn host rock, according to Mackevett.

Main workings consist of an adit driven 80 feet northeast which cuts the largest continuous orebody. This orebody strikes southeast, is 150 feet long, and ranges from 2 to 10 feet wide, averaging 3 feet in width. Other prospect holes and cuts are northwest and northeast of the adit. Samples cut by Arnold and Huffman assayed 1 to 11½ percent copper with some gold, silver and lead.

The property is idle.

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[39] Bateman, Paul C., Pine Creek and Adamson tungsten mines, Inyo County, California: California Div. Mines Rept. 41, p. 238, 1945.

[40] Aubury, Lewis E., The copper resources of California: California Min. Bur. Bull. 50, pp. 299-324, 1908.

Tucker, W. Burling, Los Angeles Field Division, Inyo County: California Min. Bur. Rept. 22, p. 463-465, 1926.

Waring, Clarence A., and Huguenin, Emile, Inyo County: California Min. Bur. Rept. 15, pp. 69-74, 1919.

[41] Mackevett, E. M., The Sally Ann copper area, Ubehebe Peak quadrangle, Inyo County, California: U. S. Geol. Survey Prelim. Rept., 1949.

Gold

Inyo County's total recorded gold production during the period 1880-1948 was $11,916,158 and represents the output from many mines in all parts of the county. Gold is often a minor but economically important constituent of ores which are mined chiefly for other metals, such as lead-silver, tungsten, and copper. Among the important gold mines in the county are the Cardinal Gold Mining Company deposit (Wilshire-Bishop Creek) 17 miles southwest of Bishop on the east slope of the Sierra Nevada; Reward mine (Brown Monster) 10 miles north of Lone Pine on the west slope of the Inyo Range; Skidoo mine at Skidoo in the Panamint Range; Ratcliff mine (Radcliff) in Pleasant Canyon on the west slope of the Panamint Range; Keane Wonder mine 22 miles west of Rhyolite, Nevada, on the west slope of the Funeral Range.

Gold deposits on the east flank of the Sierra Nevada are in quartz veins and quartzite in granitic rocks. Deposits of the Inyo Range are generally narrow veins which are either in or near the margins of granitic intrusive rocks.[42] Gold is associated with small amounts of sulphides. The orebodies of the Ratcliff mine in the Panamint Range consist of quartz lenses and masses enclosed in metamorphic rocks. At Skidoo, free gold is found in quartz veins in quartz monzonite, and at the Keane Wonder mine, lenticular quartz orebodies are enclosed in schist.

Placer gold deposits have been prospected and worked in several areas, especially in Mazourka and Marble Canyons on the west and east slopes of the Inyo Range. Production has never been great from these relatively small deposits.

Present gold mining activity is limited to a few small and scattered operations and reflects the general status of the industry. Postwar economic conditions have not been conducive to reopening many gold mines shut down by War Production Board Order L-208 issued in 1942.

Arondo Mine (Arando). Location: 11 airline miles north of Trona on the east slope of the Argus Range; sec. 30, T. 23 S., R. 43 E., M.D.M. Ownership: 28 unpatented claims are owned by Judge Russ Avery, 2700 W. 3d Street, Los Angeles, California, and the estate of Alice H. McIntosh, Paul Hopkins, executor. Two of the claims provide water for operations.

Oxidized gold ore composed of quartz fragments and stringers mixed with a talcose and clay gouge and associated siderite and hematite, is in an extensive shear zone in granitic rocks. The zone dips 54° S. and can be traced for several thousand feet along its easterly strike. The gold is free and finely divided.

Early history of the mine has not been recorded, although it probably was first worked in the 1890's.[43] Tucker and Sampson [44] summarize the work done at the mine by several operators from 1901 to 1937.

C. F. Meyer reopened the property in 1939. The 400-foot level of the Cuba No. 2 shaft was driven 500 feet east and three ore shoots, each about 100 feet long and each averaging 5 feet wide, were stoped. Approximately $60,000 was obtained for ore averaging $7.50 per ton.

Alvin B. Carpenter and associates leased the property in December 1940, sank the shaft to the 500-foot level and drove the level 500 feet east.

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[42] Knopf, Adolf, Geologic reconnaissance of the Inyo Range and the eastern slope of the southern Sierra Nevada, California: U. S. Geol. Survey Prof. Pap. 110, p. 119, 1918.

[43] Part of the information contained herein has been obtained from Alvin B. Carpenter.

[44] Tucker, W. B., and Sampson, R. J., op. cit., pp. 381-382, 1938.

Operations nearly ceased in August 1941 owing to the illness of Carpenter, but during the first six months of 1941, $22,000 worth of ore averaging $7.50 per ton was mined and milled. The ore was crushed to $\frac{1}{8}$-inch pieces and leached by cyanide. A minimum of 90 percent of the gold was recovered from the ore; the bullion was 95 percent pure, or 950 fine.

The property was leased from 1946 to 1948 to Pete Gobert and from 1948 to the early part of 1950 to A. I. Mills. Little work was done during these periods. Mr. Mills tested tailings from previous operations and explored by open cut some surface outcrops east of the mill.

The property is idle.

Ashford Mine (Golden Treasure). Location: 21 airline miles east of Shoshone on the west slope of the Black Mountains; sec. 3 (?), T. 21 N., R. 3 E., S.B.M. (projected). Ownership: 26 unpatented claims are owned by Harold Ashford, 856 N. Coronado Street, Los Angeles, California.

Seven fissure veins in pre-Cambrian granitic gneiss have been faulted and possibly rotated.[45] These veins strike N. 15° E. and dip 65° E.[46]; the width of the fissures ranges from 6 inches to 4 feet. The chief ore mineral is free gold associated with chalcopyrite, chalcocite, and bornite; one of the veins carries appreciable amounts of silver, tetrahedrite, and galena.

The 320-foot shaft, crosscut adits and winze, together with numerous related workings have been described by Tucker and Sampson.[47] The owner estimates that the workings total 4000 feet.

The gold produced has sold for $135,000, according to Harold Ashford; $18,000 worth was sold in the period 1937 to 1941.

The property is idle.

Burro and Mary F Claims (Protection Group). Location: $\frac{1}{4}$ airline mile or $\frac{3}{4}$ mile by trail east of Corona Mine in Jail Canyon on the east slope of the Panamint Mountains. Ownership: 2 lode claims are owned by S. H. Koehler, 14272 Beaver Street, San Fernando, California, Frank Carroll and D. D. Corum.

Quartz-filled fractures in schist containing free gold associated with sulphides trend northwestward and dip vertically to 65° W. Workings on the Burro claim consist of three adits, one of which is driven northwest for a distance of 300 feet. The footwall of the quartz vein in this adit dips 60°-65° W. Two other tunnels, each 35 feet in length, are 75 and 150 feet above the main adit. Surface outcrops of the quartz range from a few inches to 20 feet in width.

On the Mary F claim, a 116-foot shaft dipping 80° W. follows a quartz vein which widens from one foot at the surface to 4 feet at the bottom of the shaft.

The property is idle.

Cardinal Gold Mining Company (Wilshire-Bishop Creek).[48] Location: Middle fork of Bishop Creek, 17 miles southwest of Bishop in sec. 19, T. 8 S., R. 31 E., M.D.M. Ownership: Cardinal Gold Mining Company, 410 Roosevelt Bldg., Los Angeles, California own 34 claims, 14 of which are patented (Rocky Point Group).

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[45] Noble, Levi F., Structural features of the Virgin Springs area, Death Valley, California: Geol. Soc. Am. Bull., vol. 52, pp. 941-1000, 1941.

[46] Tucker, W. B., and Sampson, R. J., op. cit., p. 383, 1938.

[47] Tucker, W. B., and Sampson, R. J., op. cit., p. 383, 1938.

[48] Tucker, W. B., and Sampson, R. J., op. cit., pp. 389-391, 1938.

Orebodies in a fracture zone in quartzite are partly enclosed by granitic rock. The zone strikes N. 55° W. and dips 60° SW. The average width of the orebody was 8 feet. The ore minerals were free gold and several sulphides; the ore assayed $10-$12 per ton.

Operations ceased in the fall of 1938 when no new ore was discovered.

Cecil R Mine.[49] Location: 4½ airline miles S. 20° E. of Ballarat on the west slope of the Panamint Range; sec. 35, T. 22 S., R. 44 E., M.D.M. (projected). Ownership: Present ownership not established. Owned by Edward Hague and M. J. Sherlock (deceased) of Trona, California in 1938. Leased to G. C. Priest and R. L. Glassbrook in 1940-1941.

Several parallel quartz veins in schist strike north and dip 20°-30° W. The principal vein is 3 to 8 feet wide, averaging 5 feet. Most work has been done in two narrow veins in the footwall of the main vein. Workings consist of several adits, raises, stopes and winzes.

Most of the ore mined has been of high grade, assaying as much as $250 per ton.[50] Production in 1940-41 was 1200 tons of ore which sold for $23,000. Six lessees were working at that time and shipping to the Burton Brothers' mill at Tropico and Royer's mill, Randsburg.

The mine is idle.

Confidence-Mendocino Mine (Confidence). Location: 14 airline miles southwest of Shoshone, California in secs. 4 and 5, T. 20 N., R. 5 E., S.B.M. Ownership: 2 patented claims are owned by Brigham T. Cannon, 18 E. S. Temple Street, Salt Lake City, Utah.

Of a series of quartz veins in siliceous hornblende schist, the two most prominent are the Confidence, 40 feet in width and the parallel Mendocino vein, 60 feet in width. Adits, 175 and 375 feet long, have been driven on the Confidence vein, with a 200-foot vertical interval. A small amount of high-grade ore mined from raises and stopes was shipped in 1934.

The mine is idle.

Corona Mine (New Discovery and Gem). Location: 9½ airline miles north of Ballarat in Jail Canyon on the west slope of the Panamint Mountains; approximate center of T. 20 S., R. 44 E., M.D.M. (projected). Access by fair dirt road, commencing one mile west of Indian Springs and thence north to Jail Canyon. Ownership: 3 lode claims, Corona, Corona No. 1 and Corona No. 2 were purchased in 1949 from A. F. Troster on a deferred payment plan by John F. Lee, who assigned them to the present operator, Corona Mining Company, Trona, California, a mining partnership consisting of Rene Loustalot, John F. Lee and Fred Rosser. Troster obtained the claims, formerly known as New Discovery and Gem, by relocation.

A discussion of the geology of the deposit and a description of the mine workings in 1938 are included in reports by Sampson [51] and Tucker and Sampson.[52]

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[49] Sampson, R. J., Mineral resources of a part of the Panamint Range: California Div. Mines Rept. 28, p. 366, 1932.

[50] Sampson, R. J., idem.

[51] Sampson, R. J., op. cit., pp. 364-366, 1932.

[52] Tucker, W. B., and Sampson, R. J., op. cit., p. 413, 1938.

The ore is contained in quartz veins, near the contact of a schist with a sheared granitic mass. This mass has intruded Paleozoic schist, limestone, and quartzite. Ore minerals are galena, chalcopyrite, pyrite, pyrrhotite, bornite, and sphalerite. The gold is associated with the sulphide minerals.

The creek-level adit on Corona No. 1 claim now extends 370 feet north, 110 feet farther than it did in 1938. Some ore was stoped above the tunnel about 100 feet from the portal, near an old stope mentioned in the earlier reports. Troster shipped 8 tons of ore containing gold with some silver, lead, and zinc, assaying $90.00 per ton to the American Smelting and Refining Company at Selby from this old stope. The vertical 220-foot shaft, unwatered and retimbered to a depth of 95 feet (February 1950), has levels driven on the 75, 125 and 200-foot horizons. A 50-foot-long oreshoot has been mined above the 75 and 125-foot levels, from a raise starting 60 feet north of the shaft on the 125-foot level and connecting with the surface tunnel about 100 feet from the portal. A hanging wall crosscut driven from the 200-foot station cut 8 inches of ore in a stringer zone, according to Troster. Several tunnels, on both the north and south sides of Jail Canyon, have been driven in previous years. On Corona No. 2 claim, north of the shaft and on the opposite side of a ridge, an 8 to 10-foot vein striking northward and dipping 75°W. has been mined. Troster reports this ore to assay $10 to $12 per ton.

Troster sank a new 42-foot vertical prospect shaft 60 feet south of the main shaft; this exposed a quartz vein, 2-3 feet wide, striking north and dipping 68° W. Old caved workings were encountered a short distance north of the shaft bottom.

Mine equipment consists of a Gardner-Denver 6 by 5½-inch compressor and a gasoline hoist, powered by a Best 60 engine.

A 25-ton mill includes a 12 by 16-inch Pilgrim crusher, a 4- by 6-foot ball mill, a rake classifier, a 4-cell Groch flotation unit, and a concentrating table.

Five men are employed.

Davenport Mine.[53] Location: Sec. 30, T. 23 S., R. 43 E., M.D.M., 11 airline miles north of Trona, California, on a ridge between Homewood Canyon and Bruce Canyon in the Argus Range. The Arando mine adjoins on the north. Ownership: 6 claims are owned by Mrs. Nellie Wilson, Trona, California. Under bond and lease to Burton Brothers, Inc., Tropico, California.

Oxidized gold ore in which finely divided free gold is associated with quartz stringers and fragments occupies a shear zone in granitic country rock. The zone strikes N. 65° W. and dips 70° S.

The deposit has been worked by means of a shaft and three levels. The shaft, 400 feet deep, follows the dip of the fissure. On the 100-level, drifts have been run 200 feet S. 64° E. and 310 feet N. 64° W. A raise 120 feet east of the shaft connects with the surface. H. Clifford Burton estimated 25,000 tons of $6-per-ton ore was available above the 100-level. A small area west of the shaft and above the 100-level was stoped out by previous operators. The 200-level runs 190 feet N. 67° W. and 455 feet S. 64° E., with two raises east of the shaft connecting with the 100-level. Ore has been stoped by shrinkage to a point 65 feet above the

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[53] Part of the information contained herein was obtained from H. Clifford Burton (now deceased), Clifford G. Burton, and mine maps.

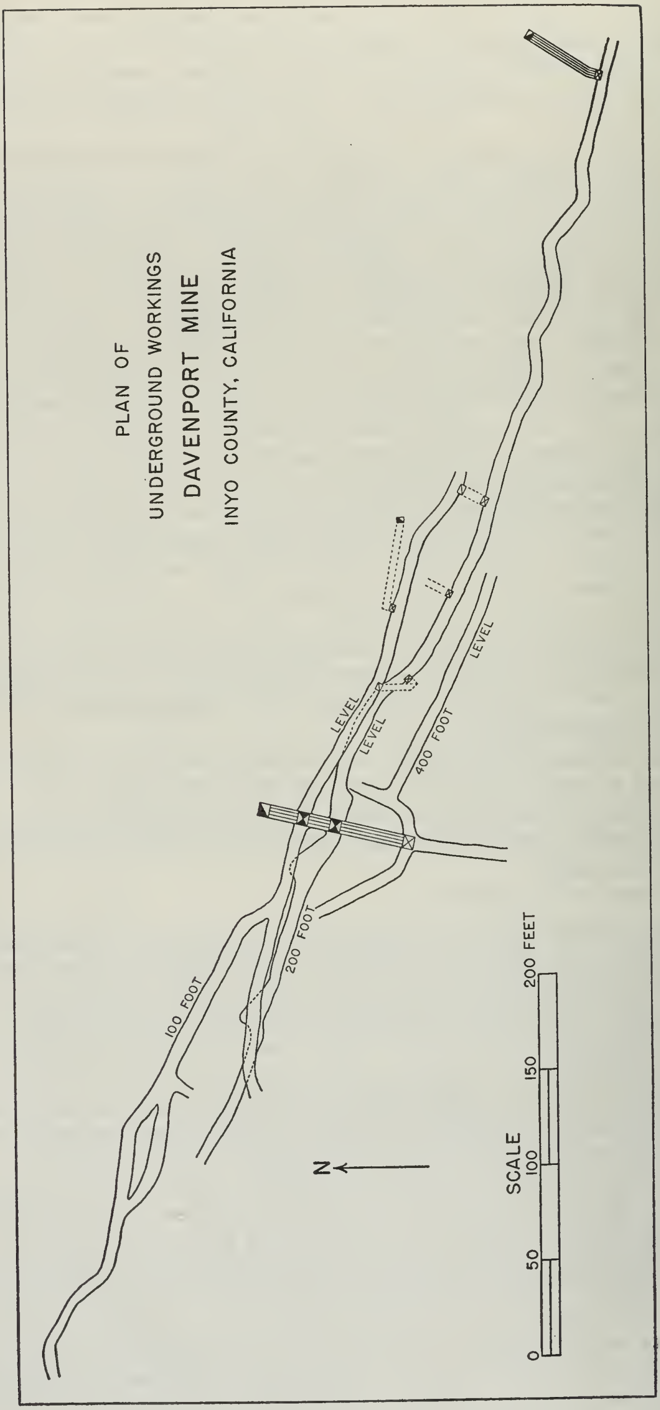
PLAN OF
UNDERGROUND WORKINGS
DAVENPORT MINE
INYO COUNTY, CALIFORNIA
100 FOOT
200 FOOT
LEVEL
LEVEL
400 FOOT
LEVEL
N
SCALE
0
50
100
150
200 FEET

FIGURE 2. Map of underground workings, Davenport mine

200-level and east of the shaft. An estimated 7000 tons of broken ore remains in the stopes. The orebody on this level was 10 to 20 feet in width and assayed about $10 per ton. Most of the ore mined to date has come from the 200-level.

The shaft was sunk by Burton Brothers from the 200-foot to the 400-foot level. The shaft followed the hanging wall of the vein. No ore was found near the shaft bottom, and a 50-foot crosscut in the hanging wall was also barren. Footwall crosscuts transected the vein but the ore was of low grade. The mine assay map and information from H. Clifford Burton indicate that the ore shoots rake flatly to the southeast.

Open-cut surface prospecting 1500 feet west of the shaft was encouraging. Future plans call for sinking a winze east of the shaft from the 200-foot level.

Ore was hauled by truck to the Ruth mine mill, a distance of 7 miles. This ore, like the Ruth mine ore, is easily cyanided when crushed to $\frac{3}{16}$-inch. Approximately $50,000 was obtained for gold recovered from 5500 tons of ore from the mine. Operations were suspended in 1942 in compliance with the War Production Board Order L-208.

The property is idle.

Del Norte Group. Location: In the Panamint Range, 1 mile north-northwest of Skidoo in sec. 13, T. 17 S., R. 44 E., M.D.M. (projected). Ownership: 6 claims are owned by Roy C. Troeger, doing business as the Panamint Milling Company, 4600 Encino Ave., Encino, California.

Gold is associated with quartz in fractures in a massive quartzite bed 25 to 30 feet thick, which strikes eastward, dips 15° N., and overlies quartz monzonite.

The deposit has been worked by several shafts, trenching and open cuts as described by Tucker and Sampson.[54]

In 1939, John M. Rogers and Joe Stivers, Mojave, California, purchased the one-third interest of Morris Albertoli and formed the Del Norte Mining Company which operated the property until 1942. During this time, 11,569 tons of ore averaging $13.40 per ton was produced from an open cut, according to records of Roy C. Troeger. The ore was milled at the Skidoo mine mill which had been acquired by surface easement. Water was hauled from Emigrant Springs, as the water rights were obtained in the purchase of Journigan's mill from Roy Journigan. Small tonnages have been mined by lessees and shipped to custom mills in recent years. Troeger reports that in 1939, the lessees sank a shallow inclined shaft on Inyo No. 2 claim and stoped a small tonnage of ore assaying $35 to $50 per ton.

The property is idle.

Golden Eagle Group. Location: Southwest slope of Gold Hill on the east slope of the Panamint Range in T. 22 S., R. 46 E., M.D.M. (projected). Ownership: 6 claims are owned by Miss Louise Grantham, 809 E. 6th Street, Ontario, California.

Gold, silver and copper minerals occur at the intersections of steeply-dipping fractures with flat-dipping limestone beds. Some high-grade ore has been mined. A 40-foot tunnel and 10-foot winze comprise the workings.

The mine is idle.

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[54] Tucker, W. B., and Sampson, R. J., op. cit., pp. 394-395, 1938.

Hornspoon Mine.[55] Location: Head of Hall Canyon in the Panamint Range; sec. 21, T. 20 S., R. 45 E., M.D.M. (projected). Ownership: Buck Johnson, Box 10, Trona, California.

A 2-foot-wide vein of crushed and cemented quartz, striking west and dipping 35° SE., has been mined by means of a 50-foot adit. At the end of the adit, a fault striking N. 45° E. and dipping 65° SE. terminates the vein, which was not found in two other adits 60 and 105 feet south and 38 feet below the first. The valuable metal is free gold embedded in limonite masses.

The property is idle.

Independent Mine (Cashier). Location: 5½ airline miles south-southeast of Skidoo in the Wildrose mining district. Easily accessible by road; 11 miles northwestward from Wildrose Springs Resort via paved road, thence 1½ miles east on the Aguereberry Point dirt road to mine. Ownership: 7 claims are owned by Ambroise Aguereberry, P. O. Box 14, Trona, California.

The Independent mine was located by J. P. Aguereberry in 1906 and worked until 1910. The Cashier Mining Company then acquired the property and worked it until 1914. J. P. Aguereberry relocated the property.

The mine workings occupy the eastern end of an isolated, elongated hill of pre-Cambrian dolomitic limestone. The limestone strikes northwestward and dips steeply to the east. The ore mineral is free gold in lens-shaped bodies of quartz, adjacent to a diorite intrusive. The bodies occupy fissures which cut the limestone; the fissures strike N. 20°-25° E. and dip 55°-70° E.

Principal workings are a 400-foot shaft inclined 55° E. with levels at 100, 200, 300, and 400 feet below the shaft collar. Most work has been done on the 100-foot level which connects with the main adit. The adit strikes S. 65° W., and has drifts 115, 210, and 270 feet from the portal. At 115 feet, the south drift connects with the shaft at a distance of 170 feet from the main adit, and continues for an additional 80 feet. An oreshoot 100 feet long has been stoped on this level between the adit crosscut and the shaft. Last production from this part came from an area 30 feet south of the adit, and was 170 tons of ore assaying 1.69 ounces of gold. A drift started south from the adit crosscut 210 feet from the portal trends southwestward and connects with the shaft. At the end of the adit, 270 feet from the portal, a drift has been driven south for a distance of 80 feet. A 40-foot winze here dips 63° SW. and is reported by Ambroise Augereberry to follow a quartz vein. The vein has a maximum 5-foot width and ore from it assays $10-$12 per ton in gold and silver.

Little work has been done on the 200-, 300-, and 400-foot levels.[56]

Several prospect shafts and tunnels are northwest of the main shaft near the ridge and toward the north base of the hill. An adit 250 feet north of the main shaft encountered 3 feet of gold-bearing quartz which assayed $7 per ton, according to Aguereberry.

Water is not available on the property. Former milling operations used water from the now-abandoned Skidoo pipeline.

The property is idle.

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[55] Murphy, F. M., Geology of a part of the Panamint Range, California: Unpublished thesis, California Institute of Technology, 1929.
Sampson, R. J., op. cit., p. 370, 1932.

[56] Waring, Clarence A., and Huguenin, Emile, op. cit., pp. 75-76, 1919.

Journigan's Mill. Location: SE¼ T. 17 S., R. 44 E., M.D.M. (projected), on the west side of the Stovepipe Wells-Wildrose Spring road, one mile south of Emigrant Springs, in Death Valley National Monument. Ownership: The mill was sold in 1938 by Roy I. Journigan to C. O. Mittendorf, who in turn sold it to Joe Stivers and John Rogers of Mojave, California.

The last ore was milled in 1938 by Journigan. Stivers and Rogers used the water acquired in their purchase for operation of a mill at Skidoo. Only a few tanks and buildings remain.

Knob Group (Anthony and Gold Bug). Location: 3½ miles east of Ballarat in Pleasant Canyon (south side) on the east slope of the Panamine Range; sec. 7, T. 22 S., R. 45 E., M.D.M. (projected). Ownership: 2 unpatented claims, Knob No. 1 and Knob No. 2, are owned by Ernest A. and Owen F. Shafter, and the Kisk Estate, P. O. Box 1048, Trona, California.

This property, first located in 1893 by C. Anthony, was relocated by the present owners in 1940.

Gold-bearing quartz ore and associated lead carbonate, iron oxide, and pyrite occur at the intersections of a series of quartz veins and fractures. The deposit and workings are described by Sampson.[57]

Ernest Shafter states that since 1940, about 700 tons of ore 3 feet wide and assaying $40 per ton has been developed. A 1750-foot aerial tramway also has been rebuilt.

The property is idle.

Lestro Mountain Mine (Gold Spur). Location: 16 airline miles N. 63° E. of Trona on a ridge between Coyote and Goler Canyons on the west slope of the Panamint Range; NE¼ T. 24 S., R. 45 E., M.D.M. (projected). Ownership: 5 unpatented claims, Soft Spot, Caliente, Caliente No. 2, Lestro, and one other are owned by Mrs. J. H. Lester, San Francisco, California.

At the Lestro Mountain mine, a gold-bearing quartz vein in granite strikes east and dips 35° SW. It ranges from 4 to 6 feet in width and has been worked by adits. On the Soft Spot claim, a crosscut adit has been driven south 150 feet to reach the vein. A drift follows the vein from the adit eastward for 125 feet. Nearly 600 tons of ore averaging $20.00 per ton was mined from a stope 40 feet long, 5 feet wide and 40 feet high.

The Caliente claim was worked by a 125-foot, south-striking crosscut adit and two 50-foot, east-west drifts.

The property was under lease to Morris Albertoli and John Rogers in 1940, who shipped 600 tons of ore to the Golden Queen Mining Company mill, Mojave, California.

The property is idle.

Lotus Mine (Monte Cristo Mines).[58] Location: 15 airline miles S. 20° E. of Ballarat in the Panamint Range; secs. 16 and 17, T. 24 S., R. 45 E., M.D.M. (projected). Ownership: 6 unpatented claims are owned by Lotus Mines, Incorporated, B. C. Flint, president, 1524 N. Buena Vista Street, Burbank, California.

A highly fractured quartzite bed overlain by dolomitic limestone contains free gold in quartz seams and fissure veins. The limestone is in contact with meta-andesite. The veins are a few inches to 4 feet in width and assay from $2.50 to $50.00 per ton. Some lead-silver-bearing veins in the limestone have been prospected.

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[57] Sampson, R. J., op. cit., pp. 368-369, 1932.

[58] Flint, B. C., private report and personal communication, May 1950.

Principal work done on the deposit consists of prospect cuts and adits. From one 210-foot adit a few hundred tons of ore was stoped in a drift 30 feet from the portal. A short adit 60 feet below the 210-foot adit also encountered ore. A third adit is 250 feet long.

Two aerial trams and a 2800-foot inclined rail-tram are used to transport ore from the mine to the camp where the road from Panamint Valley through Goler Canyon ends.

Lotus Mines, Incorporated, through their predecessors, Monte Cristo Mines, acquired the property from Carl Mengel in 1935. Ore produced from the property was sold for approximately $32,000.

Exploration and development is done intermittently.

Mohawk Mine. Location: 8 airline miles north of Trona and 2 airline miles southeast of the Ruth mine in sec. 6, T. 24 S., R. 43 E., M.D.M. (projected). Ownership: 6 claims are owned by J. C. Boyles, Trona, California; under lease to the Homewood Mining Company. Burton Brothers, Incorporated, Trona, California, have a working agreement with the Homewood Mining Company in which they hold a majority interest.

An eastward-striking vein bearing finely-divided free gold varies from 3 to 14 feet in width and dips 80° N. It consists of quartz filling in altered granitic country rock. Calcite is a prominent gangue mineral.

Principal workings consist of a 168-foot inclined shaft following the dip of the vein, a 211-foot vertical shaft, and a 200-foot adit which connects with the inclined shaft at the 60-foot level. Drifts have been driven from the inclined shaft at the 110-foot and 160-foot levels, as described by Tucker.[59]

In 1941 and 1942 Burton Brothers, Incorporated, sank a new 6 by 9-foot, 2-compartment, vertical shaft to a depth of 211 feet at a point 235 feet east of the inclined shaft. On the 168-foot level (inclined shaft designation), drifts were run 85 feet west and 110 feet east of the shaft. The vein averaged 6 feet wide and gold ore mined from it assayed $10 per ton, according to H. Clifford Burton. Approximately 1000 tons of $9-per-ton ore was mined from this level and trucked 4 miles to the Ruth mine mill. Burton estimated approximately 20,000 tons of $6 to $8-per-ton ore is available from present workings in the mine.

The property is idle.

Napoleon Group. Location: 7 airline miles south of Skidoo or 1 mile south of the Independent (Cashier) mine in sec. 21, T. 18 S., R. 45 E., M.D.M. (projected). Ownership: 4 unpatented claims, Napoleon Nos. 1, 2, 3 and 4 are owned by Ambroise Aguereberry, P. O. Box 10, Trona, California.

A series of quartz-filled fractures occurs in granitic rock. The most prominent of the fractures, a shear plane from which the ore was mined, was a few inches to five feet in width. An 80° inclined shaft 80 feet deep and several adits, all within a radius of 800 feet, comprise the workings. Most of the ore has been mined from three of the adits located 400 to 700 feet southwest of the shaft.

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[59] Tucker, W. B., and Sampson, R. J., op. cit., pp. 411-412, 1938.

Fifty-five tons of ore averaging 2.55 ounces gold and 2.16 ounces silver per ton was shipped by lessees to custom mills during intermittent operations in 1937 and 1939.

The property is idle.

New Era Mine (Buckeye or Never Rest). Location: In the Fish Springs district on the east slope of the Poverty Hills about 2 miles south of Fish Springs in sec. 27, T. 10 S., R. 34 E., M.D.M. Ownership: 12 unpatented claims are owned by W. C. Hove, Big Pine, California.

The orebody is in a mineralized, decomposed monzonite porphyry dike which strikes north, dips 35° E. and may be as much as 60 feet in width. The value of the ore ranges from $4 to $10 per ton. The present operator, W. C. Hove, has milled ore averaging $6 per ton.

The main haulage level is a 1000-foot adit, driven S. 45° W. which intersects a 60° inclined shaft at the 165-foot station. The shaft, sunk N. 45° E. near the outcrop of the dike has levels at 30, 100, and 150 feet with approximately 1000 feet of lateral workings. There are also some open cuts west of the shaft. The value of ore produced by the present operator through October 1947 has been $800 from 250 tons. Mr. Hove estimates an equal production from previous operations.

The ore was trammed to the crude-ore bin, then passed to a Sturtevant jaw crusher where the ore was crushed to $\frac{1}{4}$ inch. The fine ore was placed in two 34-ton cyanide tanks and leached in a 60-hour cycle.

The equipment includes a 125-cubic-foot Ingersoll Rand compressor. All equipment is electrically driven by power purchased from the City of Los Angeles. Water is pumped from a 100-foot well.

The property is idle.

Panamint Treasure Mine (Taylor, Treasure, and Gold Hill). Location: Warm Spring Canyon, on the southeast slope of Gold Hill. Ownership: 3 patented claims, Taylor, Treasure, and Gold Hill, 3 unpatented fraction claims, and a millsite at Arrastre Springs, totalling 90 acres are owned by Louise Grantham and associates, 809 E. 6th Street, Ontario, California.

The deposit consists of a quartz vein in limestone. Most work has been done on the Taylor claim, where two adits, 100 feet and 50 feet in length, have been driven. Miss Grantham reports that average assays of ore mined showed 1.02 ounces gold, 9.4 ounces silver and 3.2 percent lead. One hundred fifty tons of ore was shipped and 300 tons milled from 1931 to 1941.

The property is idle.

Ratcliff Mine. Location: 5 airline miles east of Ballarat in Pleasant Canyon on the east slope of the Panamint Range; sec. 8, T. 22 S., R. 45 E., M.D.M. (projected). Ownership: 10 patented claims and a millsite are owned by Mrs. W. D. Claire, P. O. Box 5, Trona, California; leased to V. D. and D. H. Claire.

The property was located in 1897 and during the period 1898-1903, 15,000 tons of ore was mined valued at $300,000.[60] D. H. Claire [61] estimates total production during that period at $1,000,000 and Murphy [62] places the production at $500,000 to $750,000 worth of ore. The mine was reopened in 1927 and from 1927 to 1942 $250,000 worth of ore was mined, according to D. H. Claire. About 20,000 tons of tailings assaying $5 to $6 per ton (gold at $20.67 per ounce) were cyanided with a recovery of $4.85 per ton.

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[60] Sampson, R. J., op. cit., p. 373, 1932.
[61] D. H. Claire, oral communication, 1949.
[62] Murphy, F. M., op. cit., p. 118, 1929.

The main Ratcliff vein strikes north to northwest and dips 45°-50° W. It is in a narrow belt of metamorphic rock, described variously as biotite schist, sericite schist, meta-quartzite or conglomerate schist. Murphy [63] includes this belt in his Panamint metamorphic complex unit. The vein or zone consists of quartz lenses and masses in which gold is associated with pyrrhotite, pyrite, and chalcopyrite.

The 7 adits and related workings of the mine total approximately 4000 feet in length; the adits cover a vertical range of about 800 feet on the south side of Pleasant Canyon. No. 1 level or adit is about 1800 feet vertically above the camp, which is in the bottom of the canyon.

Two parallel veins on a contact of granite with gneiss contain scheelite. These veins, which are just north of the mill, were prospected by means of a 100-adit and a 25-foot winze. Assays of the ore showed 0.02 percent WO_3.

In May 1949, work was being started on a lead prospect 500 feet southwest of the mill.

The mine is equipped with a mill which includes 20 stamps, 4 by 6-foot Marcy ball mill, Dorr duplex classifiers, concentrating table, agitators, and zinc boxes.

Reward Mine (also Brown Monster or Brown Monster-Reward, includes the Eclipse, Hidden Treasure Group, Hirsh and Telescope Group). Location: On the west slope of the Inyo Range about 9 airline miles southeast of Independence in sec. 3, T. 14 S., R. 36 E., M.D.M. (projected). Ownership: Basil Prescott, Beverly Hills, California owns 2 patented and 6 unpatented claims plus 2 millsites. The property is under lease and option to Dr. W. A. Wilson, Bishop, California who has subleased to T. L. Bright, Independence, California.

The deposit and mine workings are fully described by Tucker and Sampson,[64] and a complete discussion of the geology of the property is given by Knopf.[65]

The property was acquired under lease and option by the Golden Queen Mining Company, Los Angeles, and considerable exploration work was done during the period from November 1940 to April 1942. Several hundred feet of drifts and crosscuts were driven, and diamond drilling was done on both the Reward and Brown Monster veins. The fault block between the two veins was also prospected. Some ore was mined and shipped to the Golden Queen mill near Mojave, California, but the results were not favorable.

Mr. T. L. Bright, Independence, California has operated the property since 1936, except for the period of the Golden Queen operation. Some gold ore has been mined along the footwall of the old stopes, and shipped to the Tropico mill at Rosamond. A vein carrying lead, silver and gold was discovered in the upper levels of the Reward workings. The vein was exploited in 1948. Bright reported a daily production of 10 tons which was shipped via truck to the American Smelting and Refining Company plant at Selby, California. The ore is reported to assay from $100 to $150 per ton.

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[63] Murphy, F. M., op. cit., p. 119, 1929.
[64] Tucker, W. B., and Sampson, R. J., op. cit., pp. 386-388, 1938.
[65] Knopf, Adolph, op. cit., pp. 121-122, 1918.

A small mill has been constructed to concentrate some of the lower-grade ores. The crude ore is crushed to minus 1 inch in an 8 by 12-inch jaw crusher, carried by a belt conveyor to a small crushed-ore bin, and fed by a belt feeder to a 4 by 4-foot ball mill and rake classifier in closed circuit with a Denver Equipment Company jig between the ball mill discharge and the classifier. The overflow from the classifier goes to two 6 by 16-foot Wilfley concentrating tables. All the machinery is belt-driven with power furnished by a Gray 225 h.p. marine diesel engine. Mill capacity is 1¼ to 1½ tons per hour.

Three men are working in the mine and one in the mill.

Ruth Mine (Graham-Jones).[66] Location: 8½ airline miles N. 12° W. of Trona in Homeward Canyon in sec. 35, T. 23 S., R. 42 E., M.D.M. Ownership: 13 claims, Ruth, Ruth Nos. 1, 2 and 3, Island, Empire, Crown Nos. 1, 2 and 3, Red Bluff, West Extension, and Larry Jean are owned by Graham Estate, Porterville, California, F. L. Austin, Trona, California, and H. R. Evans, Kernville, California. The property is under lease to Burton Brothers, Incorporated, Tropico, California.

Iron-stained quartz fragments and stringers in a fissure in quartz monzonite carry free gold and associated pyrite. The fissure strikes N. 65° W. in the northwest part of the mine and west to slightly north of west in the southeast part and lower workings of the mine; the dip ranges from 60° SW. to 70° S.

The mine workings consist of a glory hole 200 feet long by 100 feet wide and the main working adit, called the ''tunnel level'' from which a winze and ''footwall shaft'' have been sunk; lateral workings, including the tunnel level, ''intermediate level,'' and crosscuts and drifts run from the winze and footwall shaft, are more than 2700 feet.

The tunnel level extends 1015 feet from the portal, and an orebody 225 feet long, 10 to 13 feet wide, and averaging $9.00 per ton was mined under the glory hole. Sixty feet above the tunnel-level elevation, an intermediate level was driven; the level was stoped and is now inaccessible.

A winze 525 feet from the portal of the tunnel level was sunk 350 feet, S. 20° W. at an average inclination of 65°. Drifts were run in orebody on the 100-, 200-, and 300-foot levels. The footwall shaft, inclined 60° S., located 542 feet from the portal of the tunnel level, was started 45 feet north of the fissure and sunk to a depth of 500 feet. Crosscuts varying from 45 to 60 feet long were driven to intersect the 100-, 200-, and 300-foot winze levels and to cut the orebody on the 400-foot level.

Drifts on the 100-, 200-, 300-, and 400-foot levels were 275, 312, 140, and 200 feet in length respectively; the length of the orebody exposed on the four levels was 220, 230, 180, and 220 feet respectively. The width of the orebody mined was from 10 to 15 feet and the ore assayed $10 to $15 per ton, according to H. Clifford Burton. Some higher grade ore was found; ore assaying $40 per ton was mined from the 300-foot level. On the 500-foot level, an 80-foot crosscut south of the shaft failed to cut the ore but a test hole drilled from the heading showed ore. The level was not surveyed and is under water. Several tons of broken ore remains between

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[66] Part of the information contained herein was obtained from H. Clifford Burton (now deceased), Clifford G. Burton, and mine maps.

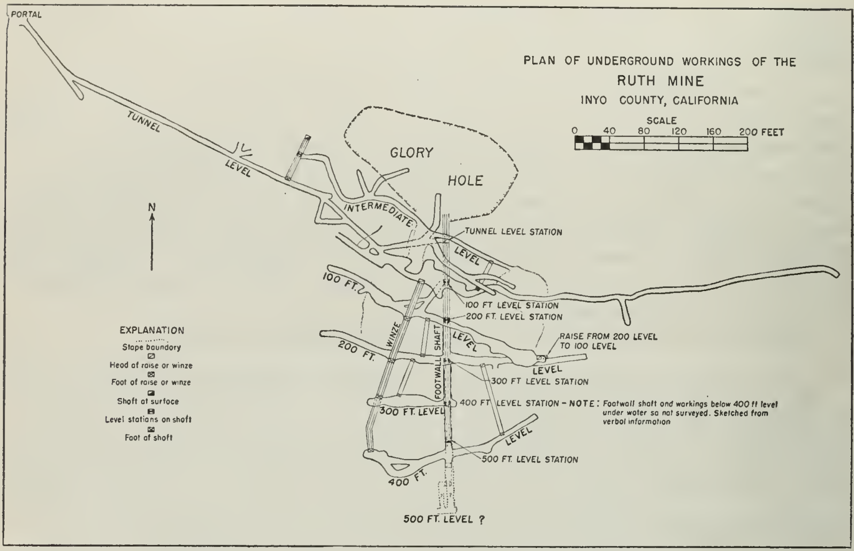
PORTAL
PLAN OF UNDERGROUND WORKINGS OF THE
RUTH MINE
INYO COUNTY, CALIFORNIA
SCALE
0 40 80 120 160 200 FEET
TUNNEL LEVEL
GLORY HOLE
N
INTERMEDIATE LEVEL
TUNNEL LEVEL STATION
100 FT. LEVEL
100 FT LEVEL STATION
200 FT. LEVEL STATION
EXPLANATION
Stope boundary
Head of raise or winze
Foot of raise or winze
Shaft at surface
Level stations on shaft
Foot of shaft
WINZE
FOOTWALL SHAFT
200 FT. LEVEL
RAISE FROM 200 LEVEL TO 100 LEVEL
300 FT LEVEL STATION
300 FT. LEVEL
400 FT LEVEL STATION
NOTE: Footwall shaft and workings below 400 ft level under water so not surveyed. Sketched from verbal information
400 FT. LEVEL
500 FT. LEVEL STATION
500 FT. LEVEL ?

FIGURE 3. Map of underground workings, Ruth mine

the 200- and 400-foot levels as well as a block of unmined ore at the east end of the 400-foot level. Burton believes that the greatest possibilities for ore lie in the east part of the mine below the tunnel level.

A new cyanide mill was constructed in 1941 and used until operations were suspended by War Production Board Order L-208. Ore was delivered from the glory hole by truck and from other workings by mine cars to the mill. The ore, crushed to $\frac{3}{16}$-inches, was leached in a series of five 100-ton tanks and valuable metals were precipitated by a Merrill-Crowe unit. The leaching period was 5 days. Two pounds of sodium cyanide and 6 pounds of lime were used per ton of ore. The ''heads'' or average grade ore was valued at $10 per ton; ore from the glory hole assayed $4 to $6 per ton; an average ton of tailings recovered from all ore processed in the mill contained gold worth 70 cents. The cost of milling ore in the new mill was 50 cents per ton, as compared with 90 cents per ton in the old mill. Power was supplied by a 75 kw generator driven by a diesel engine.

H. Clifford Burton stated that their operations produced $550,000 worth of ore. Former operators probably mined 10,000 tons of ore from the glory hole.[67]

The property is idle.

St. George Mine (Merry Christmas). Location: 10 airline miles S. 10° E. from Panamint Springs on a ridge north of Snow Canyon in the Argus Range; sec. 8 (?), T. 20 S., R. 42 E., M.D.M. (projected). Ownership: 12 claims are owned by J. C. Cress Estate and Mary E. Streger, Los Angeles, California (1938).

Two systems of quartz veins, each vein 2 to 4 feet wide, occur in a granitic rock; one system strikes N. 50° W., dips 70° to 75° SW. and the other strikes eastward, dips 70° S. The ore consists of free gold associated with pyrite, chalcopyrite, and arsenopyrite. The workings, described by Tucker and Sampson,[68] include several adits and a 200-foot shaft (St. George).

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[67] Tucker, W. B., and Sampson, R. J., op. cit., p. 417, 1938.

The property is idle.

Skidoo Mine (Silver Bell).[69] Location: 14 airline miles north-northeast of Wildrose Station at the old camp of Skidoo in the Panamint Range. Ownership: 12 claims are owned by W. Howard Gray, Ely, Nevada.

Two systems of quartz veins occur in quartz monzonite, one system striking northwestward and dipping 30° to 40° southwest and the other striking eastward and dipping 60° north. The veins, ranging from 18 inches to 4 feet wide, assay from $15 to $20 per ton in free gold. A 300-foot inclined shaft sunk on the east vein system, a 300-foot vertical shaft on the main vein system, and more than one mile of workings are on the property.

Various lessees have worked the property in recent years. In 1937 and 1938, Roy Journigan mined a small amount from the old stopes which, together with some dump material, was treated at his mill in Emigrant Canyon. During 1940-42, Del Norte Mining Company (John Rogers and Joe Stivers) mined 3723 tons of ore averaging $30 per ton, according to records of Roy C. Troeger. This ore, together with some Del Norte mine tonnage, was treated at the Skidoo mine mill, which had been acquired by surface easement. Ore was hauled by truck to a 50-ton ore bin, crushed to $\frac{1}{4}$-inch size by two jaw crushers in series, reduced to 16-mesh by stamps, and the coarse gold concentrated and removed. The pulp was then thickened, the slimes going to waste and the sands (about three-fifths of the total) leached.

Southern Homestake Mine (Southern Homestead). Location: 8 airline miles south of Ballarat in Redlands Canyon; sec. 18, T. 23 S., R. 45 E., M.D.M. (projected). Ownership: 10 unpatented claims are owned by Harry Briggs, Trona, California.

A wide brecciated diorite sill, associated with steeply west-dipping limestone and quartzite beds, contains auriferous pyrite. The sill, now altered and silicified, has intruded along the contact of the quartzite with granite porphyry.

The deposit is worked by open cuts and by a series of interconnected tunnels and lateral workings totalling more than 1600 feet.

Samples tested show the ore to be worth $7 to $16 per ton. The ore-bodies, which carry more gold in areas of intense brecciation, range from 4 to 10 feet in width.

The owner is engaged in surface stripping of promising areas with a bulldozer.

Stockwell Mine. Location: 8 airline miles N. 35° E. of Trona on the west slope of the Slate Range. The camp and mill are in sec. 14, T. 24 S., R. 43 E., M.D.M.; the mine is 3 miles northeast of the mill. Ownership: 7 unpatented claims in the mine area and 40 acres of located and patented land are owned by Stockwell Gold Mining Corporation, E. E. Teagle, president, P. O. Box 507, Trona, California.

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[68] Tucker, W. B., and Sampson, R. J., op. cit., pp. 418-420, 1938.

[69] Tucker, W. B., and Sampson, R. J., op. cit., pp. 420-421, 1938.

This gold deposit is a shear zone filled with crushed quartz, talc, and altered granitic country rock; the zone strikes N. 20° W., dips 60° NE. and ranges from 3 to 30 feet in width. The gold is associated with pyrite and some chalcopyrite. A few pockets of high-grade ore are found along the strike. Teagle states that over 7500 feet of workings are on the property. A description of the workings has been given by Tucker and Sampson.[70]

Since 1938, Teagle has mined 130 tons of ore assaying $16 per ton from the Goff, Bertha, and Edwin claims. Operations were suspended in 1942 by War Production Board Order L-208.

In 1941 a mill was constructed by Teagle and C. H. Lockwood. Lockwood milled 300 tons of dump ore which assayed from $1 to $25 per ton. The mill plant and equipment includes ore bins, jaw crusher, 4- by 5-foot ball mill, rake classifier, concentrating table, and a 4-cell flotation unit. Water is supplied by a nearby well.

Rehabilitation of the surface plant, mill and mine workings has been started (March 1950).

Sunset Mine. Location: 1½ airline miles south of Skidoo in the Panamint Range. The mine is just south of the Skidoo road at a point 3 miles east of the paved Wildrose-Emigrant Canyon road in the Death Valley National Monument. Ownership: 4 claims, Sunset Nos. 1 and 2, National and St. Lawrence, are owned by W. M. G. Walters, Box 1143, Trona, California. Formerly owned by B. L. Allen, 4031 Eagle Street, Los Angeles, California.

A quartz vein which strikes N. 35° E. in quartz monzonite is associated with a granitic dike. The vein is exposed by prospect holes for 200 feet along the surface. The irregular orebodies range from a few inches to 6 feet in width. Workings, as described by B. L. Allen, consist of a timbered shaft striking S. 32° E. and dipping 75° SW. Drifts about 50 feet long have been run on the 50-, 100-, and 125-foot levels. Some stoping was done above the 50-foot level. From the surface to the 50-foot level, the ore averaged 4 feet in width and carried 0.50 ounce of gold per ton. The vein is widest east of the shaft near a north-trending fault.

Approximately 100 tons of ore carrying an average of $20 worth of gold per ton has been shipped from the mine to custom mills. Some silver is also recovered from the ore.

The mine is now idle, having been worked last in 1940.

Tucki Mine.[71] Location: On the southeast slope of Tucki Mountain in the Panamint Range, 4 airline miles north-northeast of Skidoo and 10 miles by road from Emigrant Canyon via Telephone Canyon. Ownership: 4 unpatented lode claims are owned by Roy I. Journigan, 709 E. Beverly Boulevard, Whittier, California and Ed Attaway, Lone Pine, California.

Free gold associated with quartz occupies fractures in a bed of quartzite which strikes N. 55° W. and dips 55° SW. An irregularly inclined (average 50° SE.) shaft has been sunk to the 200-foot level and continued as a winze to a depth of 330 feet. Lateral workings consist of 15-foot drifts at the 50- and 100-foot levels, a 40-foot drift driven southwest on the 130-foot level, an 80-foot drift driven south on the 170-foot level, and a 40-foot drift driven east on the 200-foot level. The deposit was first prospected by two adits 60 and 200 feet northwest of the shaft.

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[70] Tucker, W. B., and Sampson, R. J., op. cit., pp. 422-423, 1938.
[71] Information in part by oral communication, Roy I. Journigan.

The total amount of gold produced to date is unknown, but from August 1940 to April 1941 lessees sold $5,200 worth of ore which averaged $20 per ton; assays showed the gold content to range from $12 to $60 per ton. Ore mined since 1940 has been treated in a small cyanide plant on the property. Ore mined before 1940 was treated at Journigan's custom mill in Emigrant Canyon.

The property is idle.

Iron

Deposits of iron ore containing hematite as the chief ore mineral are in the southern and southeastern sections of Inyo County but have not been worked extensively. Many of the deposits are lenticular bodies in or closely associated with granitic rock, although some are contact-metamorphic replacement bodies of iron ore in limestone. Most of the deposits are in the Argus Range and Coso Mountains, and several are within the boundaries of the U. S. Naval Ordnance Test Station. Iron ore from the Argus Range was utilized as a flux in early-day smelters at Darwin.

Iron Cap Deposit (Hoot Owl, Monarch Iron Consolidated Mines, Primus). Location: 8½ airline miles S. 60° W. from Ballarat on the east slope of the Argus Range. Monarch Iron Consolidated group (Hoot Owl) is in secs. 28-29, T. 22 S., R. 43 E., M.D.M.; Primus claim is in sec. 30, T. 22 S., R. 43 E., M.D.M. Ownership: 5 unpatented claims, Monarch Iron, Monarch Iron 1-3 and Primus and a patented millsite are owned by Percy Hagerman (Trustee), care of El Paso Club, Colorado Springs, Colorado.

A deposit of iron ore, principally hematite with some magnetite, at the contact of granite with limestone has been worked by a 150-foot vertical shaft and a 275-foot adit 500 feet north-northeast of the shaft.

The only recorded history of the mine before 1939 is the statement by Crawford that the property was a source of flux material for the Lookout smelter prior to 1893.[72] From 1939 to 1941, L. E. Netherton and C. F. Knotts shipped about 3000 tons of ore to Bradley and Ekstrom, Incorporated, San Francisco. Metallic iron content of the shipments ranged from 59.21 to 66.97 percent, silica ranged from 3.31 to 9.64 percent, with a trace of sulphur.

The property is idle.

Iron Chief and Ferro Group. Location: 6 airline miles N. 10° W. of Trona, California; sec. 13, T. 23 S., R. 41 E., M.D.M. Ownership: Within U. S. Naval Ordnance Test Station, Inyokern, California.

The property was located originally by A. Schultz of Brown, California and relocated in 1940 by J. T. McCord and others. Ore from this deposit, too, was used for flux at the Darwin district smelters.

Lenses of hematite and magnetite in granite strike north, dip 10° W. Several open cuts and pits comprise the workings.

Iron Chief Iron Deposit. Location: 23 miles northeast of Brown, California in sec. 18, T. 23 S., R. 42 E., M.D.M. Ownership: Within U. S. Naval Ordnance Test Station, Inyokern, California.

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[72] Crawford, J. J., op. cit., p. 326, 1894.

A 1½ square mile area contains a series of small, high-grade veins of hematite in granitic rock. Several small pits and open cuts have exposed masses as much as 16 feet wide but short in length and shallow in depth. Assays indicate a low phosphorus and sulphur content with 60 to 65 percent iron.

LeCyr Iron Deposit (Valley View Claim). Location: 15 miles northeast of Olancha in sec. 1, T. 19 S., R. 38 E., M.D.M. Ownership: One unpatented claim is owned by J. R. LeCyr, Santa Rosa Mining Company, Keeler, California.

The deposit includes two veins of hematite, 75 feet apart, in a silicified, brecciated limestone associated with granitic rock. Both veins strike N. 30° E.; the east vein dips N. 40° W. and the west vein dips S. 70° E. Granitic rock borders the brecciated limestone on the east.

An adit driven N. 70° W. a distance of 110 feet exposes 12 feet of ore. Assays of the ore are as follows:

	Fe	P	S	SiO_2
Surface (chip sample)	39.51	0.024	0.008	34.22
Sorted ore	50.10	0.014	0.006	24.62

Estimated reserves total 45,000 tons of indicated and inferred ore based upon 6 and 7½-foot widths and 200 and 425-foot lengths of the two veins.

Millspaugh Iron Deposit[73] *(Big 4 Iron Nos. 1, 2, and 3).* Location: 18 airline miles southeast of Darwin in sec. 9, T. 22 S., R. 42 E., M.D.M. Ownership: Within U. S. Naval Ordnance Test Station, Inyokern, California. Claimant: Nathan Burton, Los Angeles. Claims: Big 4 Iron Nos. 1, 2, and 3.

Irregular lenses of hematite and magnetite in granitic country rock are mined by open cuts 6 to 8 feet deep and 20 feet long. An analysis of a composite sample of ore by California Testing Laboratories showed 67 percent iron, 4.8 percent silica, 0.01 percent sulphur, and 0.03 percent phosphorus.

Mister Mine. Location: In the Amargosa Range, two miles southeast of Bradbury Well, in sec. 24, T. 21 N., R. 4 E. and sec. 19, T. 21 N., R. 5 E., S.B.M., about 14 airline miles southwest of Shoshone, California. Ownership: 14 unpatented claims are owned by Lance Smith, Puente, California and L. S. McGirk and L. S. McGirk, Jr., 3438 Freer Street, El Monte, California.

A zone of fine-grained specular hematite in a light-colored granite gneiss crops out for a distance of 3000 feet. The zone is about 100 feet wide and strikes N. 85° W. and dips from 35° to 50° N. Only pockets of hematite have been mined, although fracture planes in the gneiss contain some hematite, and small amounts of it are disseminated throughout the gneiss.

One 80-foot crosscut adit and two open cuts have produced about 300 tons of ore, all of which has been used for welding-rod coatings and agricultural purposes. Crushing and screening of the ore to 200-mesh has increased the iron content from 18.80 percent in the raw ore to 46.90 percent in the concentrate. In 1936 shipments of selected ore, screened to

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[73] Tucker, W. B., Current Notes, Inyo County: California Div. Mines Rept. 42, p. 319, 1946.

200-mesh, assayed 63.22 percent Fe_2O_3, 4.27 percent SiO_2 and 0.21 percent Al_2O_3. A U. S. Geological Survey partial analysis of iron oxide powder screened ore is as follows:[74]

SiO_2	11.14 percent
Al_2O_3	6.08
Fe	56.84
MgO	0.20
CaO	0.16
TiO_2	0.10

The property is idle.

Lead, Silver, Zinc

The first lead mined in California was probably that produced by Mormons from the southern part of the Panamint Range before 1859. Since then, mines in Inyo County have been the principal sources of lead in California, and in addition have produced considerable silver and zinc.

Silver and zinc minerals accompany those of lead in most of the deposits, which typically are cavity fillings or replacement bodies in calcareous rocks. The three major lead-producing areas in Inyo County are the Cerro Gordo, Darwin, and Tecopa districts.

The Cerro Gordo district produced the most lead, silver and zinc, valued at more than $17,000,000.[75] There has been no large lead-silver production since 1877, but most of the zinc was mined separately from secondary ore bodies in the Cerro Gordo mine during the period 1911 to 1915. This mine has been the most important in the district.

The Darwin district had produced about $7,000,000 worth of ore before the principal mines were purchased by the Anaconda Copper Mining Company in 1945.[76] In recent years Anaconda's Darwin Mines have been the chief source of lead in California. From figures published since 1945 on rate of production and grade of ore, it is estimated that the total value of lead, silver, and zinc produced in the district is now $15,000,000. The Zinc Hill area has produced zinc as both sulphide and oxidized ores, and was one of the largest producers of zinc ore in Inyo County in 1918.

The Tecopa district produced more than $3,000,000 worth of ore before 1928 [77] and is now the second most important lead-producing district in the state, having a probable total production of $7,000,000 worth of lead and silver. The Gunsight, Noonday and War Eagle are among the mines consolidated under the name, Shoshone Mines, which is owned and operated by the Anaconda Copper Mining Company.

Considerable amounts of lead-silver ore have been produced from the Modoc and Slate Range districts, and small amounts from the Ubehebe, Leadfield, and other districts. Silver ore has been produced from veins in the Panamint City area, but not in recent years.

American Silver Corporation. Location: 30 miles N. 33° E. of Trona in Surprise Canyon on the west slope of the Panamint Range and in the vicinity of Panamint City. Ownership: 12 patented claims, 4 patented millsites and 42 unpatented claims held by lease and location by American Silver Corporation, N. James Elliott, president, Beverly Hills. Patented claims leased included the Panamint Mines group and the Challenge.

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[74] Burchard, E. F., Summary of the iron ore situation in California: California Div. Mines Bull. 129, p. 229, 1948.

[75] Tucker, W. B., and Sampson, R. J., op. cit., p. 426, 1938.

[76] Davis, D. L., and Peterson, E. C., Anaconda's operation at Darwin Mines, Inyo County, California: Am. Inst. Min. Eng. Trans., vol. 181, p. 137, 1949.

[77] Tucker, W. B., and Sampson, R. J., op. cit., p. 426, 1938.

Ore deposits of the Panamint district have been described in various reports.[78] The properties of the American Silver Corporation are in an area of about one square mile, in which three main veins striking northeast and dipping steeply northwest and several intersecting veins have been mined.

Most of the work done in 1947-48 was on the Marvel claim, where a 600-foot adit was driven. A silicified limestone zone was intersected 400 feet from the portal and was explored by 40 feet of drifts. On the Hemlock claim, a 30-foot adit was started 300 feet below the old tunnels to intersect the Hemlock vein. Other work included an adit driven on the Wyoming claim and some prospecting. No ore was reported as shipped.

Camp buildings and facilities were built at Panamint City, and the road in Surprise Canyon rebuilt. The Corporation filed a petition in bankruptcy March 22, 1948.

The property is idle.

Argenta Mine.[79] Location: 8 airline miles S. 16° E. of Skidoo on the north side of Wood Canyon in the Panamint Range; sec. 27, T. 18 S., R. 45 E., M.D.M. (projected). Ownership: 9 unpatented claims are owned by George Griest, P. O. Box 10, Trona, California.

Replacement bodies of galena, lead carbonate, zinc carbonate, and sphalerite associated with calcite and iron-manganese-stained limestone, are in a zone of contact of limestone with schist and quartzite. The vein strikes east, dips 70° N. and is 6 to 12 feet wide.

A 30-foot shaft has been sunk on ore near the top of the ridge. On the north slope of Wood Canyon, south of the shaft and 375 feet vertically below the outcrop, an adit has been driven N. 12° W. for a distance of 630 feet. About 600 feet from the portal, a lateral working has been driven N. 35° E. for 130 feet. Eighty feet from the junction of the adit and lateral, a crosscut was run 44 feet north. At the end of the crosscut a raise was driven 100 feet in search of the downward extension of the surface outcrop. No ore has been mined from the adit workings. Tucker and Sampson [80] report that 70 tons has been produced from the property, the shipments assaying 27 percent lead and $8 per ton in gold and silver. The ore has averaged 12 percent zinc, 5 percent lead, 2.80 ounces silver, and 0.08 ounce gold.

The mine is equipped with a machine shop, assay office, Ingersoll-Rand portable compressor, and camp buildings.

Two men are employed in prospecting work at the north end of the adit.

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[78] Murphy, F. M., Geology of the Panamint silver district, California: Econ. Geol., vol. 25, no. 4, pp. 305-325, 1930.
Murphy, F. M., op. cit., 1929.
Murphy, F. M., Geology of a part of the Panamint Range, California: California Div. Mines Rept. 28, pp. 329-356, 1932.
Sampson, R. J., op. cit., pp. 359-364, 1932.
Tucker, W. Burling, op. cit., p. 495, 1926.

[79] Tucker, W. Burling, and Sampson, R. J., op. cit., p. 59, 1943.

[80] Tucker, W. Burling, and Sampson, R. J., idem.

Big Four Mine (War Eagle). Location: On the east side of Panamint Valley in sec. 25, T. 17 S., R. 42 E., M.D.M. (projected), 7 airline miles northeast of Panamint Springs, California. Ownership: 3 claims are owned by Mrs. Agnes Reid, Panamint Springs; Silas Ness, Olancha, California; William Braun, Bishop, California, and Marie Keck, Los Angeles, California.

Replacement-type ore is in a brecciated and altered zone in limestone and consists mainly of cerussite, with some zinc and silver. Narrow seams of cerussite are in a zone 1-foot to 4-feet thick. The zone dips to the northwest about 30°.

The workings are on two levels. The lower level is a short adit driven S. 20° E., ending in a small irregular slope. The upper level has a 110-foot adit driven along a fault S. 55° E. The adit ends in an irregular 80-foot stoped section. Recently, an adit was driven eastward from the portal of the lower adit; stoping will continue from this new heading.

A 900-foot crosscut adit was driven N. 70° E. at the base of the hill many years ago.

To the northwest across the canyon, two 30-foot adits have been driven N. 25° E. and N. 30° E. by Richard B. Walls, a lessee, in 1947. Thirty tons of shipping-grade ore was produced.

The present location of the property was made by William Reid in 1940 and the first work was done in 1942. The property was leased to Elmer Perry in 1944 and 1945, and 372 tons of ore was mined during this period. In 1946 the property was operated by William Braun and Silas Ness, who shipped 11 cars of ore during 1946.[81]

In May 1949 the property was under lease to Lee Foreman and William Skinner and some work was done by two men on contract basis.

The property is idle.

Black Canyon Mine (Black Canyon Group, Mineral Point, Sanger). Location: On a ridge on the western slope of the White Mountains 2 miles south of Black Canyon Spring in secs. 13, 14, 23 and 24, T. 7 S., R. 34 E., M.D.M. (projected); 10½ airline miles eastward from Bishop. Ownership: 6 unpatented claims, the Hope group, are owned by Morris Albertoli and associates, Big Pine, California.

Limestone overlying quartzite and slate contains irregular replacement lenses of galena and cerussite in fissures. On the south slope of the ridge, an open cut and a 60-foot inclined shaft have been sunk on a fissure which strikes north and dips 45° W. An adit 65 feet lower than the open cut has been driven N. 70° W. intersecting this fissure at 75 feet and continuing to 115 feet. A drift was run north 60 feet on the fissure to the intersection of the fissure with a vertical, east-striking fissure. In this drift, 20 feet from the adit, a 40-degree inclined winze was sunk on the north-striking fissure. Beyond this another winze was sunk to a depth of 60 feet on the east-striking fissure. Ore bodies in these workings average two feet in width. The 600 tons of ore shipped assayed 60 percent lead, 150 ounces of silver and 0.10 ounce of gold per ton.

On the north slope of the ridge, an adit has been driven south 440 feet. A fissure, striking N. 60° W. and dipping 45° NE., was intersected 315 feet from the portal, and 170 feet of drifts were driven on the fissure. Lenses of ore were cut in these workings.

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[81] Reid, Mrs. Agnes, oral communication, 1949.

Before 1947, 900 tons of ore worth an average of $60 per ton was shipped. Albertoli reported that five cars of ore were shipped during 1947.

The property is idle.

Cerro Gordo Mine (Includes the Aries Consolidated Group, S½ Armagh Mine, Bluff Group, Boushey Silver, Ignacio or Ygnacio, Mormon, New Enterprise, Omega Group, Pagan Group, Santa Maria, Summit No. 2, and Union Mines). Location: In the Inyo Range near Cerro Gordo Peak in secs. 12, 13, 23 and 24, T. 16 S., R. 38 E., M.D.M. (projected) and sec. 18, T. 16 S., R. 39 E., M.D.M. (projected) at an altitude of 8500 feet, about 5 airline miles northeast of Keeler, California. Ownership: 44 patented claims are owned by W. C. Rigg and associates, 595 E. Channel Road, Santa Monica, California. 4 unpatented claims are still owned by the Silver Spear Mining Corporation, George Merritt, Santa Barbara, California, president.

The deposit and mine workings have been described by Tucker and Sampson.[82] Knopf [83] has given a complete description of the geology of the district and mine. The lenticular ore bodies are mesothermal fissure deposits which have replaced Devonian marble. Geologic work indicates that ore deposition was controlled partly by bedding in Devonian quartzite.[84] The ore bodies are composed of argentiferous galena, cerussite, anglesite, smithsonite, sphalerite, tetrahedrite and pyrite. The general trend of the orebodies is north or northwest, the dip about 70° W., and the plunge south.

Two of the largest orebodies were the China Stope orebody, which was mined to a depth of about 550 feet, and the Jefferson orebody, which had a vertical dimension of more than 1000 feet. The Jefferson is 800 to 950 feet south of the China Stope.

Most of the lead and silver was produced before 1877. During the period 1911 to 1915, a large amount of secondary zinc ore was mined, principally from orebodies on the footwall side of the China Stope.

The principal opening is the 900-foot Belshaw shaft with levels at 85, 200, 400, 550, 700 and 900 feet. On the 900-foot level, 160 feet north of the shaft, a winze was sunk 200 feet with drifts on the 1000 and 1100 levels. About 470 feet south of the shaft, a 250-foot winze was sunk and drifts were extended from the bottom and the 1030-foot level. Underground workings total more than 15 miles.

In 1940 the Cerro Gordo group was acquired by the Silver Spear Mining Corporation. The property was operated from October 1943 to March 1945 by the Golden Queen Mining Company of Los Angeles. Their work consisted of diamond drilling and drifting to find a faulted segment of the Jefferson orebody. Ore was mined from the 900-foot level, and between 750 and 1000 tons of ore was shipped which assayed 17.50 percent lead and 13.2 ounces of silver.

In 1946 the property was leased to W. R. Rigg and associates and was purchased by them in 1949. Exploration work in and around the China Stope area between the 200 and 550 levels, included several thousand feet of diamond drilling and several thousand feet of drifts, raises and winzes. Some diamond drilling was also done from the 900-foot level.

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[82] Tucker, W. B., and Sampson, R. J., op. cit., pp. 431-433, 1938.

[83] Knopf, Adolph, op. cit., pp. 106-116, 1918.

[84] Merriam, C. W., Geology of the Cerro Gordo mine area, Inyo County, California (abstract): Econ. Geol., vol. 44, p. 82, 1949.

A small amount of ore was shipped but the property is now idle. The value of ore produced from the Cerro Gordo District is estimated to be $17,000,000, of which the Cerro Gordo Mine produced ore worth $15,000,000.[85]

Christmas Gift Mine. Location: 1¾ airline miles north of Darwin in SE¼ sec. 11, T. 19 S., R. 40 E., M.D.M. Ownership: 5 unpatented mining claims, the Small Boy, Boston, California, Red Top, and Missing Link Fraction are owned by L. D. Skinner, Lone Pine, California, and Louis V. Skinner, 247½ N. Virginia Street, Reno, Nevada. The property is under lease and option to the Christmas Gift Mines, Incorporated, George E. Loit and associates, 9715 Venice Boulevard, Los Angeles 34, California.

The Christmas Gift vein strikes N. 40° E. and dips about 80° NW. in distinctly stratified tactite country rock. The tactite has been intruded by numerous dikes and irregular offshoots from the Darwin stock of granodiorite, and is cut by an intricate system of fissures and faults. The tactite strikes N. 30° W. and dips S. 30°-40° W.

The Christmas Gift shaft was sunk on the vein to the 250-foot level with levels at 50-foot intervals. About 200 feet to the southwest of the shaft on the 250-foot level, a 45-degree inclined winze was sunk to a depth of 200 feet. Drifts were driven from the winze. Other workings include the Johnny John shaft inclined to a depth of 250 feet, the Ing shaft, 90 feet deep, a 300-foot adit called the Fault Tunnel, a shorter adit called the Boe Tunnel, and several shallow shafts and open cuts.[86]

The ore minerals in the vein consist of galena and the oxidation products cerussite and anglesite in a gangue of earthy iron oxides derived from pyrite and jasper. The ore shoot from which practically all the ore has been produced is about 300 feet long, and was mined from above the 250-foot level. The vein is cut off on the 250-foot level by a fault about 200 feet northeast of the shaft. The fault strikes N. 70° E. and dips 75° S.

The mine, inactive since 1920, has produced an estimated $500,000 worth of ore. The ore is reported to assay 15 to 30 percent lead, 20 to 30 ounces of silver per ton and a little gold.[87]

The present operators sampled, surveyed, and rehabilitated the mine during 1949 in preparation for development work on the 250-foot level. A crosscut to the northwest on this level is planned in an effort to encounter the faulted segment of the vein.

Five men are employed.

Darwin Mines (includes the Bernon, Columbia, Defiance, Driver, Essex, Independence, Lane, Liberty Group, Lucky Jim, Promontory, Rip Van Winkle, Southwest, and Thompson mines). Location: North of Darwin in the Darwin hills, 30 miles east of Olancha and U. S. Highway 6, in secs. 11, 12, 13, 14, 23 and 24, T. 19 S., R. 40 E., M.D.M. Ownership: The Anaconda Copper Mining Company, 25 Broadway, New York 4, New York, William H. Hoover, president, owns 45 patented and 44 unpatented mining claims plus several millsites. S. K. Droubay, manager, Dudley L. Davis, chief engineer-geologist.

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[85] Tucker, W. B., and Sampson, R. J., op. cit., pp. 426, 431, 1938.
[86] Austin, B. C., private report for Christmas Gift Mines, Inc., May 1949.
[87] Tucker, W. Burling, Inyo County: California Min. Bur. Rept. 17, p. 285, 1921.

The first mines at Darwin were located in November 1874.[88] Before 1880, several mills and smelters were in operation and the town of Darwin had a population of more than 5000. The district flourished during the mining of the rich, oxidized lead-silver ores. As these surface ores were exhausted, however, the isolation of the district and unfavorable price fluctuation of metals allowed only intermittent operations until World War I, during which some of the principal mines, the Lucky Jim, Promontory, Lane and Columbia, were operated by the Darwin Development Company, the Darwin Lead-Silver Development Company, and finally by the Darwin Silver Company. The Darwin Silver Company consolidated the Defiance and Independence mines with the others.

In 1919, the brokerage firm of E. W. Wagner and Company gained control of the properties, and under the management of A. G. Kirby, installed surface equipment, prepared some of the properties for production and remodeled the Lane mill. In 1921 the Wagner Company went bankrupt, and the Wagner Assets Realization Corporation, a creditors' organization, was formed to take charge of the assets. From 1922 to 1925 A. G. Kirby operated the properties on a lease. In 1925, C. H. Lord obtained a lease and bond on the properties and operated them as C. H. Lord, Trustee, until 1927. He then formed the American Metals, Incorporated, and continued operations until the end of that year. The Wagner Assets Realization Corporation then attempted to regain possession of the properties, but certain legal difficulties were not straightened out until 1936. Two of C. H. Lord's financial backers formed the Darwin Lead Company, obtained a lease and bond on the properties, and commenced operations in the fall of 1936 and continued until the summer of 1938. The Imperial Smelting and Refining Company, Mr. Sam Mosher and Mr. Ralph Davies and associates began operating the property in 1940. Later Mr. Davies withdrew, and Mr. Mosher and an association of officers of the Signal Oil Company continued operations as the Imperial Metals, Incorporated. In March 1943, Arthur J. Theis and associates took over the operation under the name of Darwin Mines, although Imperial Metals, Incorporated retained an interest. The Anaconda Copper Mining Company purchased the property on August 1, 1945.

The orebodies occur as replacements of silicated limestone rocks, as bedded replacements, or as fissure fillings.[89] All of these are in a thick series of Paleozoic (probably Pennsylvanian) limestone, dolomite, shale and quartzite which have been folded and faulted.

The principal structure is a northwest-pitching anticlinal fold, the crest of which lies just west of the ridge line of the Darwin hills. The east flank of this fold has been intruded by the Darwin granodiorite stock and its associated dikes and sills which grade from granite to gabbro. Peripheral to the stock is a silicated (tactite) zone which is as much as 2500 feet wide. All metallization is related to this stock.[90] The sedimentary series has been intruded on the west and south by the Coso granite batholith.

The three principal systems of faults are post-intrusion and pre-mineralization in age with some post-mineralization movement. The Dar-

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[88] Chalfant, W. A., The story of Inyo, p. 294, Chalfant Press, revised ed., 1933.
[89] Davis, D. L., and Peterson, E. C., op. cit., p. 137.
[90] Kelley, V. C., op. cit., p. 514, 1938.

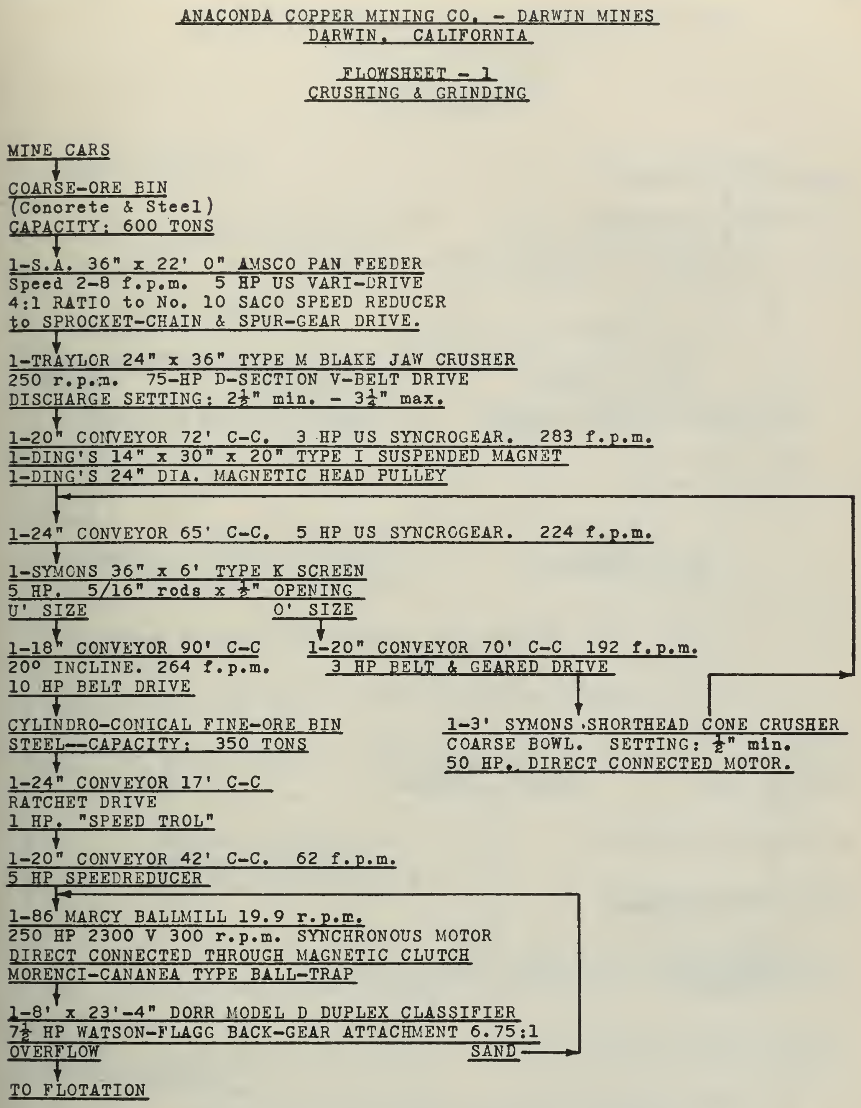
ANACONDA COPPER MINING CO. - DARWIN MINES
DARWIN, CALIFORNIA
FLOWSHEET - 1
CRUSHING & GRINDING
MINE CARS
COARSE-ORE BIN
(Conorete & Steel)
CAPACITY: 600 TONS
1-S.A. 36" x 22' 0" AMSCO PAN FEEDER
Speed 2-8 f.p.m. 5 HP US VARI-DRIVE
4:1 RATIO to No. 10 SACO SPEED REDUCER
to SPROCKET-CHAIN & SPUR-GEAR DRIVE.
1-TRAYLOR 24" x 36" TYPE M BLAKE JAW CRUSHER
250 r.p.m. 75-HP D-SECTION V-BELT DRIVE
DISCHARGE SETTING: 2½" min. - 3¼" max.
1-20" CONVEYOR 72' C-C. 3 HP US SYNCROGEAR. 283 f.p.m.
1-DING'S 14" x 30" x 20" TYPE I SUSPENDED MAGNET
1-DING'S 24" DIA. MAGNETIC HEAD PULLEY
1-24" CONVEYOR 65' C-C. 5 HP US SYNCROGEAR. 224 f.p.m.
1-SYMONS 36" x 6' TYPE K SCREEN
5 HP. 5/16" rods x ½" OPENING
U' SIZE
O' SIZE
1-18" CONVEYOR 90' C-C
20° INCLINE. 264 f.p.m.
10 HP BELT DRIVE
1-20" CONVEYOR 70' C-C 192 f.p.m.
3 HP BELT & GEARED DRIVE
CYLINDRO-CONICAL FINE-ORE BIN
STEEL—CAPACITY: 350 TONS
1-3' SYMONS SHORTHEAD CONE CRUSHER
COARSE BOWL. SETTING: ½" min.
50 HP. DIRECT CONNECTED MOTOR.
1-24" CONVEYOR 17' C-C
RATCHET DRIVE
1 HP. "SPEED TROL"
1-20" CONVEYOR 42' C-C. 62 f.p.m.
5 HP SPEEDREDUCER
1-86 MARCY BALLMILL 19.9 r.p.m.
250 HP 2300 V 300 r.p.m. SYNCHRONOUS MOTOR
DIRECT CONNECTED THROUGH MAGNETIC CLUTCH
MORENCI-CANANEA TYPE BALL-TRAP
1-8' x 23'-4" DORR MODEL D DUPLEX CLASSIFIER
7½ HP WATSON-FLAGG BACK-GEAR ATTACHMENT 6.75:1
OVERFLOW
SAND
TO FLOTATION

FIGURE 4. Flow sheet, Darwin Mines mill, crushing and grinding

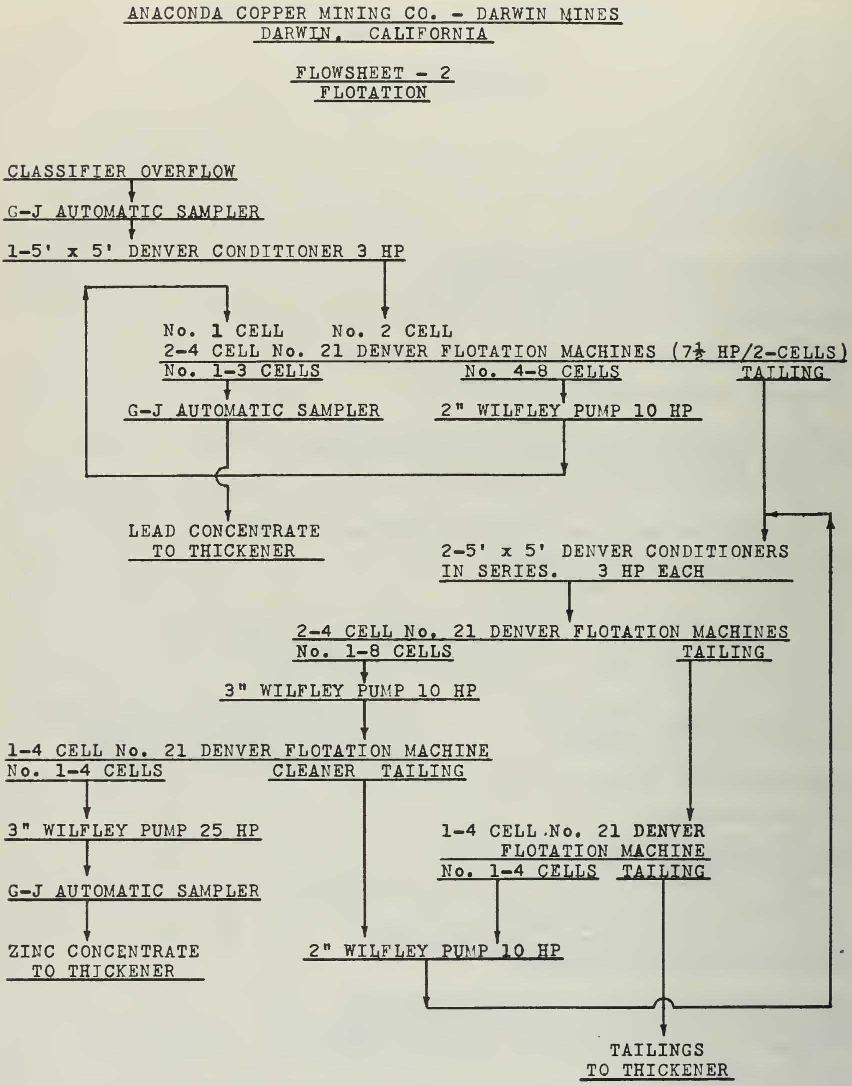
ANACONDA COPPER MINING CO. - DARWIN MINES
DARWIN, CALIFORNIA
FLOWSHEET - 2
FLOTATION
CLASSIFIER OVERFLOW
G-J AUTOMATIC SAMPLER
1-5' x 5' DENVER CONDITIONER 3 HP
No. 1 CELL
No. 2 CELL
2-4 CELL No. 21 DENVER FLOTATION MACHINES (7½ HP/2-CELLS)
No. 1-3 CELLS
No. 4-8 CELLS
TAILING
G-J AUTOMATIC SAMPLER
2" WILFLEY PUMP 10 HP
LEAD CONCENTRATE TO THICKENER
2-5' x 5' DENVER CONDITIONERS IN SERIES. 3 HP EACH
2-4 CELL No. 21 DENVER FLOTATION MACHINES
No. 1-8 CELLS
TAILING
3" WILFLEY PUMP 10 HP
1-4 CELL No. 21 DENVER FLOTATION MACHINE
No. 1-4 CELLS
CLEANER TAILING
3" WILFLEY PUMP 25 HP
1-4 CELL No. 21 DENVER FLOTATION MACHINE
No. 1-4 CELLS
TAILING
G-J AUTOMATIC SAMPLER
ZINC CONCENTRATE TO THICKENER
2" WILFLEY PUMP 10 HP
TAILINGS TO THICKENER

FIGURE 5. Flow sheet, Darwin Mines mill, flotation

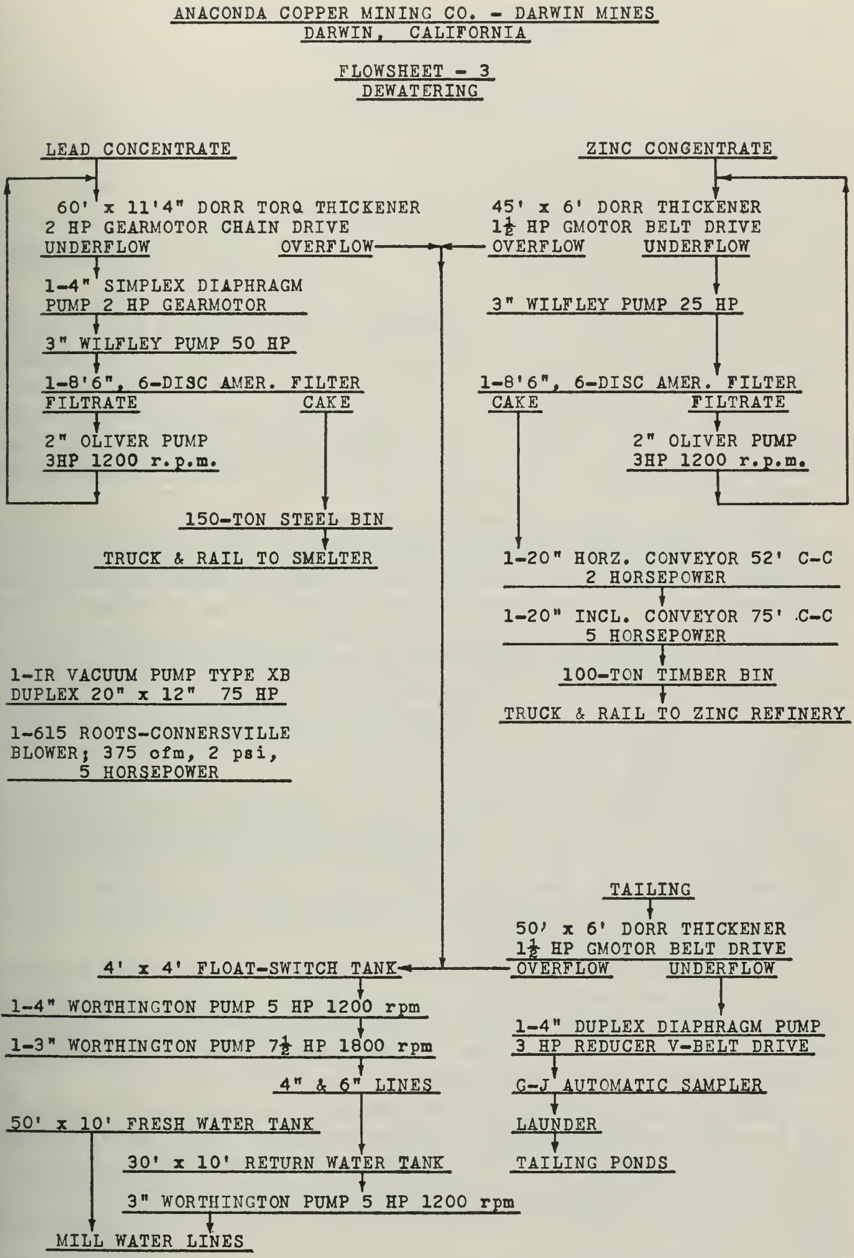
ANACONDA COPPER MINING CO. - DARWIN MINES
DARWIN, CALIFORNIA
FLOWSHEET - 3
DEWATERING
LEAD CONCENTRATE
60' x 11'4" DORR TORQ THICKENER
2 HP GEARMOTOR CHAIN DRIVE
UNDERFLOW
OVERFLOW
1-4" SIMPLEX DIAPHRAGM PUMP 2 HP GEARMOTOR
3" WILFLEY PUMP 50 HP
1-8'6", 6-DISC AMER. FILTER
FILTRATE
CAKE
2" OLIVER PUMP 3HP 1200 r.p.m.
150-TON STEEL BIN
TRUCK & RAIL TO SMELTER
ZINC CONCENTRATE
45' x 6' DORR THICKENER
1½ HP GMOTOR BELT DRIVE
OVERFLOW
UNDERFLOW
3" WILFLEY PUMP 25 HP
1-8'6", 6-DISC AMER. FILTER
CAKE
FILTRATE
2" OLIVER PUMP 3HP 1200 r.p.m.
1-20" HORZ. CONVEYOR 52' C-C 2 HORSEPOWER
1-20" INCL. CONVEYOR 75' C-C 5 HORSEPOWER
100-TON TIMBER BIN
TRUCK & RAIL TO ZINC REFINERY
1-IR VACUUM PUMP TYPE XB DUPLEX 20" x 12" 75 HP
1-615 ROOTS-CONNERSVILLE BLOWER; 375 cfm, 2 psi, 5 HORSEPOWER
TAILING
50' x 6' DORR THICKENER
1½ HP GMOTOR BELT DRIVE
OVERFLOW
UNDERFLOW
4' x 4' FLOAT-SWITCH TANK
1-4" WORTHINGTON PUMP 5 HP 1200 rpm
1-3" WORTHINGTON PUMP 7½ HP 1800 rpm
4" & 6" LINES
1-4" DUPLEX DIAPHRAGM PUMP 3 HP REDUCER V-BELT DRIVE
G-J AUTOMATIC SAMPLER
LAUNDER
TAILING PONDS
50' x 10' FRESH WATER TANK
30' x 10' RETURN WATER TANK
3" WORTHINGTON PUMP 5 HP 1200 rpm
MILL WATER LINES

FIGURE 6. Flow sheet, Darwin Mines mill, dewatering

win tear fault is the largest in the district. It strikes N. 60° to 75° W., dips steeply south, and is traceable for 10 miles.

The ore minerals in the unoxidized ore zones are argentiferous galena and sphalerite with lesser amounts of chalcopyrite and tetrahedrite in a pyrite, fluorite, and calcite gangue. Extensive near-surface leaching of zinc, sulphur and iron has produced high-grade ores consisting of cerussite, anglesite, plumbojarosite and some bunches of galena. Several rare minerals and several hundred tons of high-grade tungsten ore (scheelite) were mined from one of the stopes in the oxidized zone. Accessory minerals in the oxidized zone are iron oxides, jasper, clays, sulphur, gypsum, jarosite, calcite, hydromica, quartz and fluorite.

The main haulage way and entry for the Darwin Mines is the Radiore tunnel, the 400-level, which was started in 1926. This crosscut has connected the workings of the Defiance mine, the Bernon mine and the Independence-Thompson group (pl. 2). The tunnel was driven 1430 feet N. 20° E., then 2740 feet N. 15°-20° W., then more than 1200 feet north. Its total length is more than one mile of which the Anaconda Company has driven more than 2400 feet.

The Defiance Mine was formerly worked through an adit and a 500-foot shaft inclined at 35 degrees. The altitude of the shaft collar and adit portal is 5234 feet. Workings from these openings are connected to the Rediore tunnel by raises, but an inclined winze goes down to the 570 level. A raise and winze, now jointly called the main working shaft, connect the Independence and Thompson group with the Radiore tunnel and extend to the 600 level. These mines were formerly worked through tunnels, the portals of which are at altitudes of 5617 feet for the Independence and 5291 for the Thompson. Two other tunnels are the Essex, at 5557 feet, and the Intermediate, at 5472 feet.

Mining methods are adapted to the conditions in the ore zones. Square sets are used in the oxidized zone. A slot method is used in these square-set stopes, somewhat modified from the Butte method in that waste fill is seldom used. In the large replacement orebodies, pillars are left between the square-set stopes and are subsequently recovered by a modified Mitchell top-slicing method.

In the unoxidized zones, the narrow orebodies are mined by open or rill-type stopes, and the larger, hard sulphide orebodies are mined by sub-level stoping. The sub-levels are spaced at vertical intervals of 21 feet, and each level is developed to the limits of the ore before actual mining is started. Some shrinkage stopes have been used.

Underground workings total several miles in length and new workings are advanced at a rate which has averaged more than 7000 feet per year since 1947. Diamond drilling is used for exploration and has averaged about 9000 feet per year for the years 1947-49. Core recovery is high. Practically all mining and development work is done on a contract basis.

Storage battery locomotives are used for haulage, and modern equipment is used throughout the mine. All mucking is done with mechanical loaders. Headings on the main level are drilled with drifters mounted on hydraulic jumbos. Detachable throw-away bits are used. Electric hoists are used in the shaft and winzes.

The mill, which has a capacity of about 300 tons per day, is just below the portal of the Radiore tunnel. Both oxidized and mixed oxide-

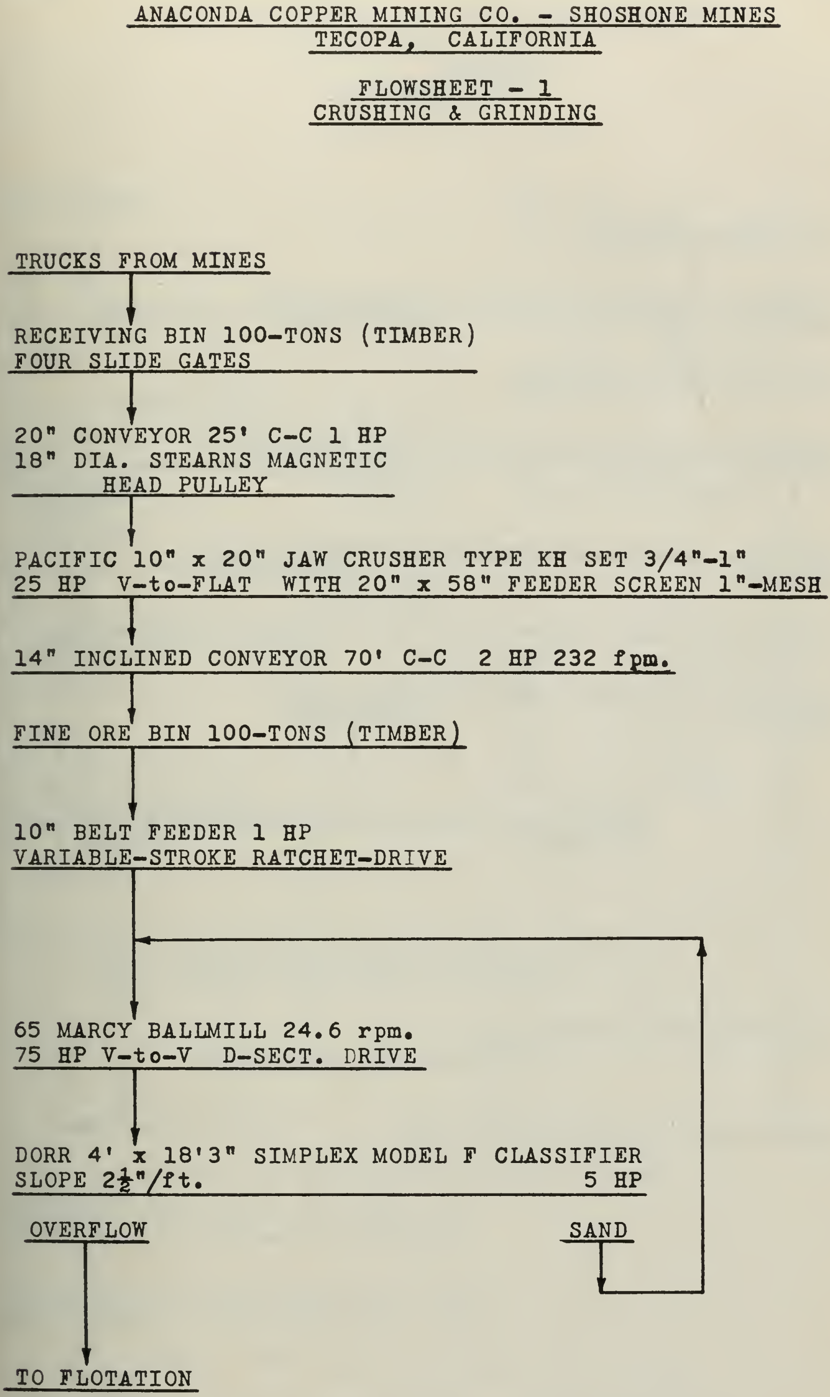
ANACONDA COPPER MINING CO. - SHOSHONE MINES
TECOPA, CALIFORNIA
FLOWSHEET - 1
CRUSHING & GRINDING
TRUCKS FROM MINES
RECEIVING BIN 100-TONS (TIMBER)
FOUR SLIDE GATES
20" CONVEYOR 25' C-C 1 HP
18" DIA. STEARNS MAGNETIC HEAD PULLEY
PACIFIC 10" x 20" JAW CRUSHER TYPE KH SET 3/4"-1"
25 HP V-to-FLAT WITH 20" x 58" FEEDER SCREEN 1"-MESH
14" INCLINED CONVEYOR 70' C-C 2 HP 232 fpm.
FINE ORE BIN 100-TONS (TIMBER)
10" BELT FEEDER 1 HP
VARIABLE-STROKE RATCHET-DRIVE
65 MARCY BALLMILL 24.6 rpm.
75 HP V-to-V D-SECT. DRIVE
DORR 4' x 18'3" SIMPLEX MODEL F CLASSIFIER
SLOPE 2½"/ft. 5 HP
OVERFLOW
SAND
TO FLOTATION

FIGURE 7. Flow sheet, Shoshone Mines mill, crushing and grinding

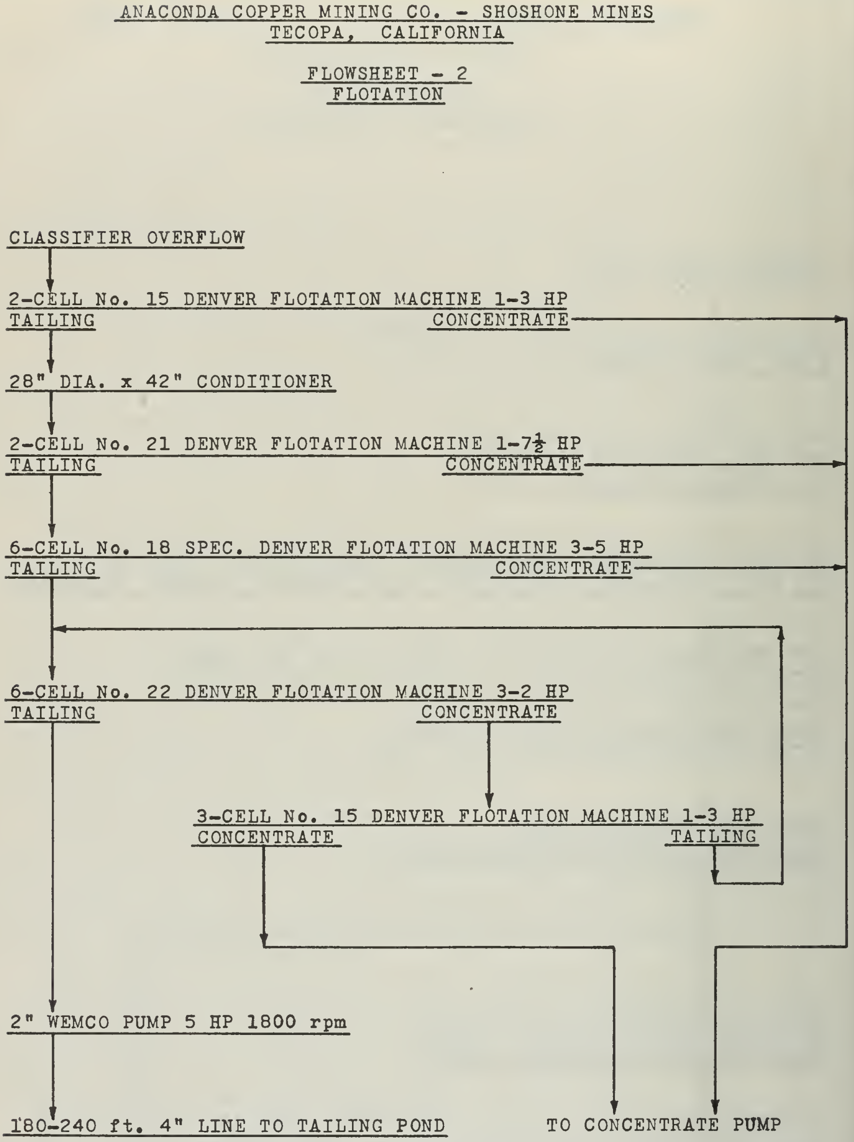
ANACONDA COPPER MINING CO. - SHOSHONE MINES
TECOPA, CALIFORNIA
FLOWSHEET - 2
FLOTATION
CLASSIFIER OVERFLOW
2-CELL No. 15 DENVER FLOTATION MACHINE 1-3 HP
TAILING
CONCENTRATE
28" DIA. x 42" CONDITIONER
2-CELL No. 21 DENVER FLOTATION MACHINE 1-7½ HP
TAILING
CONCENTRATE
6-CELL No. 18 SPEC. DENVER FLOTATION MACHINE 3-5 HP
TAILING
CONCENTRATE
6-CELL No. 22 DENVER FLOTATION MACHINE 3-2 HP
TAILING
CONCENTRATE
3-CELL No. 15 DENVER FLOTATION MACHINE 1-3 HP
CONCENTRATE
TAILING
2" WEMCO PUMP 5 HP 1800 rpm
180-240 ft. 4" LINE TO TAILING POND
TO CONCENTRATE PUMP

FIGURE 8. Flow sheet, Shoshone Mines mill, flotation

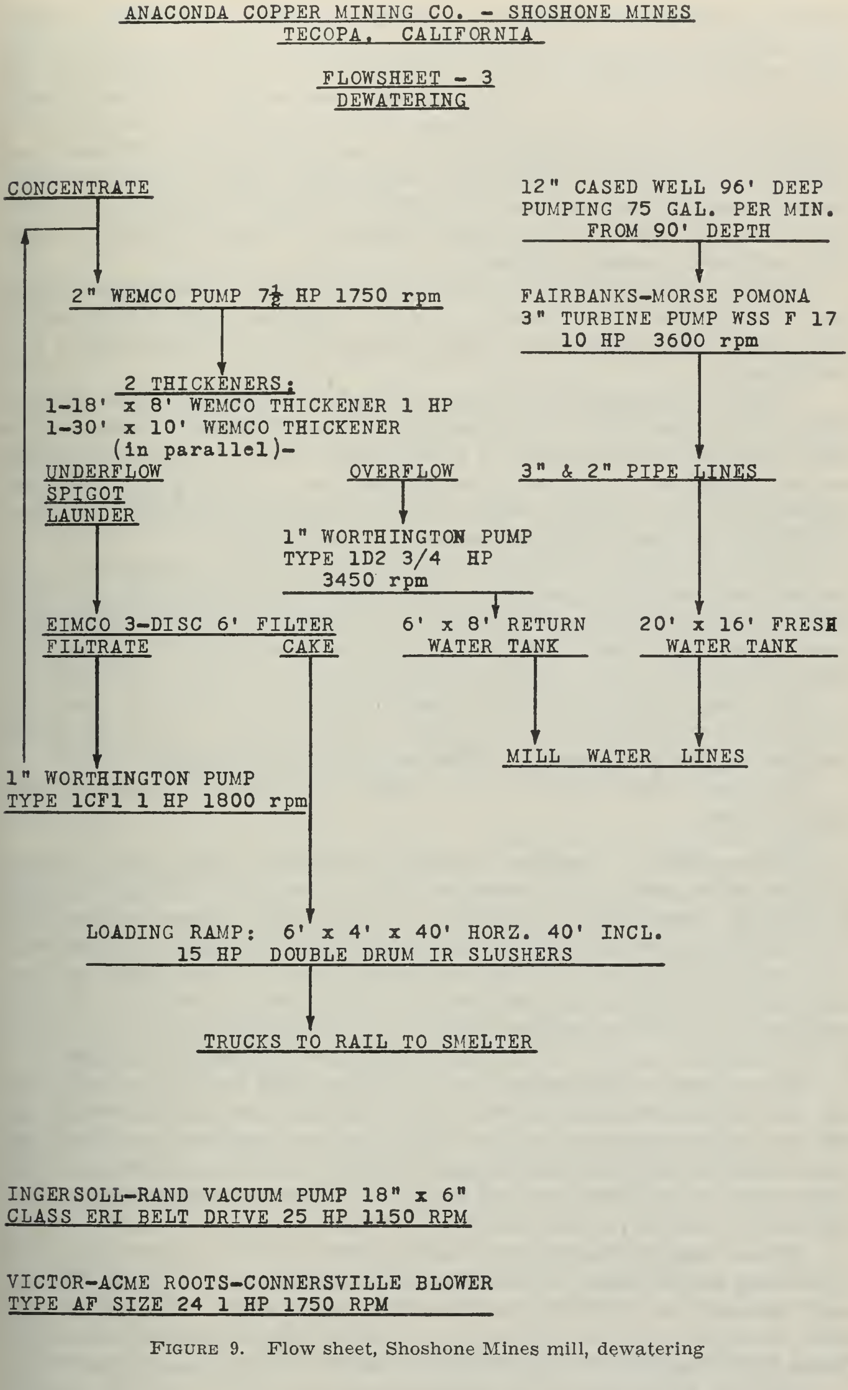
ANACONDA COPPER MINING CO. - SHOSHONE MINES
TECOPA, CALIFORNIA
FLOWSHEET - 3
DEWATERING
CONCENTRATE
12" CASED WELL 96' DEEP PUMPING 75 GAL. PER MIN. FROM 90' DEPTH
2" WEMCO PUMP 7½ HP 1750 rpm
FAIRBANKS-MORSE POMONA 3" TURBINE PUMP WSS F 17 10 HP 3600 rpm
2 THICKENERS:
1-18' x 8' WEMCO THICKENER 1 HP
1-30' x 10' WEMCO THICKENER
(in parallel)-
UNDERFLOW SPIGOT LAUNDER
OVERFLOW
3" & 2" PIPE LINES
1" WORTHINGTON PUMP TYPE 1D2 3/4 HP 3450 rpm
EIMCO 3-DISC 6' FILTER
FILTRATE
CAKE
6' x 8' RETURN WATER TANK
20' x 16' FRESH WATER TANK
MILL WATER LINES
1" WORTHINGTON PUMP TYPE 1CF1 1 HP 1800 rpm
LOADING RAMP: 6' x 4' x 40' HORZ. 40' INCL. 15 HP DOUBLE DRUM IR SLUSHERS
TRUCKS TO RAIL TO SMELTER
INGERSOLL-RAND VACUUM PUMP 18" x 6" CLASS ERI BELT DRIVE 25 HP 1150 RPM
VICTOR-ACME ROOTS-CONNERSVILLE BLOWER TYPE AF SIZE 24 1 HP 1750 RPM

FIGURE 9. Flow sheet, Shoshone Mines mill, dewatering

sulphide ores were treated after Anaconda started operations. The mill was enlarged to its present capacity and the flow sheet changed so that now only the sulphide ores are treated (figs. 4-6). Lead and zinc are concentrated separately in the flotation process. The zinc concentrate is shipped to Great Falls, Montana, and the lead-silver concentrate is shipped to Tooele, Utah. Only shipping-grade oxidized ore is mined. Any lower-grade oxidized ore obtained is stockpiled. Mill heads before 1947 average about 10 percent lead, 4.5 percent zinc and 7 ounces of silver,[91] and since then have averaged approximately 7.5 percent lead, 7.5 percent zinc and 5 ounces of silver.

Power is obtained from the City of Los Angeles through Anaconda's own 18-mile line to the Olancha cut-off. Compressed air is supplied by 3 Ingersoll-Rand compressors with a total capacity of 3000 cubic feet per minute.

Water for milling and all camp purposes is obtained from Darwin Wash about three miles from the camp. Water is pumped from shallow wells, 24 to 50 feet deep, into a 30,000-gallon tank. An automatic float-control regulates the operation of the pumps. A 120-gallon-per-minute triplex pump then lifts the water 1800 feet through a 4-inch line to three 50,000-gallon storage tanks above the mill and camp.

The production record of these properties is not complete. For the period October 1941 to mid-July 1943, 28,400 tons of ore was mined, of which 11,400 tons was milled before it was decided that the oxidized ore was not amenable to the treatment. The 17,000 tons shipped to the smelter averaged 9 percent lead and 4 percent zinc.

The total production of the district before the Anaconda operation is estimated at $7,000,000 worth of lead, silver and zinc. Anaconda's current production averages about 8000 tons of ore per month.

The usual crew is 180 men; the mine operates on two shifts and the mill on three.

Defense Mine. Location: On the east slope of the Argus Range, 8 airline miles south of Panamint Springs, in secs. 28, 29, T. 19 S., R. 42 E., M.D.M. (projected). Ownership: 3 unpatented claims are owned by L. D. Foreman and William V. Skinner, Panamint Springs, California.

Ore is in irregularly shaped replacement bodies along bedding plane slips in the Pennsylvania limestone beds. The limestone strikes N. 70° W. and dips 65° N. The oreshoots pitch to the northeast. The ore minerals are coronadite, an oxide of lead and manganese, galena and cerussite.

The original work consisted of an 18-foot shaft sunk on a coronadite outcrop. A crosscut adit, 77 feet below this, has been driven 220 feet to the ore. Two raises were run from this adit to explore the ore. The shaft now connects with the adit through the stope on the main orebody. One large stope on the adit level has produced an estimated 4400 tons of ore which averaged 25 percent lead.

Ore is transported from a loading chute near the adit portal over a 540-feet aerial tram to a truck-loading storage bin. During 1949 an adit was started 150 feet lower than the main entry. This will be the main haulage way and will connect with the upper level by means of raises. Ore is handled underground by slushers. Eight men are employed.

Earliest production of the mine during the 1930's was 225 tons of ore averaging 17 to 18 percent lead. Since the acquisition of the property in 1947 by Foreman and Skinner, a total of 7000 tons of ore has been produced. Assays of the first 100 tons averaged 20.5 percent lead and 9 to 12 ounces of silver per ton. Underground samples have shown the manganese content to range from 18 to 27 percent.

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[91] Davis, D. L., and Peterson, E. C., op. cit., p. 146.

Empress Mine. Location: In the north end of the Argus Range, on the west slope of Zinc Hill approximately in sec. 2, T. 19 S., R. 41 E., M.D.M. (projected) about 6 airline miles northeast of Darwin. Ownership: one-third of each 4 unpatented claims are owned by Sam L. Holcomb, 810 Lake Street, Bakersfield, California, Jess G. Sutleff, Independence, California; and Florence Williams, 263 Walnut Street, Brookline, Massachusetts.

A quartz vein in granite near a contact with limestone strikes N. 80° E. and dips 35° N. Although the width of the vein ranges from 6 inches to 2 feet in surface expostures, it is as much as 3 feet underground.

Ore minerals are argentiferous galena and its alteration products and minor amounts of silver bromide, sphalerite, and oxidized copper minerals.

Three drift adits are connected by raises, and the vein has been partially stoped between levels. Underground workings total about 300 feet.

The first ore was produced in 1946 and 1947 by Edward H. Dopplemayr and Marion Crandall of Darwin, who shipped 167 tons of ore valued at $10,325. The present lessee, W. E. McCulley of Darwin, had shipped 226 tons with a total value of $16,683 through March 1949.[92] Assays of shipments have shown a range from 25.0 to 39.9 percent lead, 6.02 to 6.50 percent zinc, trace to 2.9 percent copper and 15.05 to 27.0 ounces of silver per ton.

Equipment on the property includes a Worthington 105 portable air compressor. Four men are working.

Estelle and Morning Star Mines. Location: On the west slope of the Inyo Range about 4½ airline miles northeast of Keeler in secs. 23, 24, and 26, T. 16 S., R. 38 E., M.D.M. (projected). Ownership: The Estelle Mining Corporation, Walter Davis, president, Roy C. Troeger, secretary, 4600 Encino Avenue, Encino, California, owns 71 lode claims, tunnel sites and millsites, which total approximately 1400 acres. In 1941 the property was leased by the Signal Oil and Gas Company, and since 1945 it has been under lease to Mr. Sloan Flack and associates, 811 W. 7th Street, Los Angeles, California.

The deposit and the workings have been described by Tucker and Sampson.[93] All of the ore bodies are in structurally-controlled fractures in Devonian limestone. Ore minerals are argentiferous galena and its oxidation products. The principal opening is the Estelle or Dellaphine tunnel which was driven N. 70° E. for a distance of 8070 feet. The portal of this tunnel is at an altitude of 6268 feet. About 7500 feet from the portal there is an 800-foot vertical raise with level workings at 140, 340 and 660 feet above the tunnel. The raise and its workings are caved and inaccessible. The underground openings, including the Estelle tunnel, had a total length of 18,027 feet.

Ore mined from the Estelle tunnel was from a vein called the San Felipe, but recent mapping indicates that the vein worked was actually a parallel vein and that the San Felipe vein was not reached.[94] Total production from the Estelle tunnel is reported at 2700 tons of ore averaging 21.61 percent lead, 20.8 ounces of silver and 0.16 ounce of gold per ton.[95]

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[92] Sutleff, Jess G., oral communication.

[93] Tucker, W. B., and Sampson, R. J., op. cit., pp. 437-440, 1938.

The principal orebody on the Morning Star mine was called the Gold Stope orebody, because the ore carried 0.80 ounce of gold in addition to 30.67 ounces of silver and 5.55 percent lead. The mine has two tunnels and workings on six levels totaling 6400 feet, exclusive of winzes, raises and stopes. The Morning Star tunnels are at altitudes of 7972 feet and 7754 feet. Ore was hauled over an aerial tram to a terminus near the road between the Cerro Gordo mine and Keeler. Total production from this mine was 6000 tons of ore having a gross value of $150,000.[96]

Intermittent prospecting, sampling and mapping, principally on the Morning Star mine, is supervised by W. L. Eckloff.

Fernando and St. Charles Group (includes Durham, Fernando, Hayward and St. Charles). Location: In the Darwin Hills 1 mile east of Darwin in sec. 24, T. 19 S., R. 40 E., M.D.M. Ownership: 7 patented claims are owned by C. W. Fletcher, Big Pine, California (formerly the Darwin Consolidated Tungsten Corporation, Los Angeles).

These properties, originally exploited for lead and silver, were inactive from the late twenties until early in 1941. Ore shipped from the Fernando mine before the period of inactivity is reported to have assayed 30 percent lead and 30 ounces of silver per ton.[97] The ore minerals, galena, cerussite, and anglesite, are associated with jasper, hematite, limonite, and calcite in orebodies at the intersection of a prominent cross fracture with the tactite bedding.

In 1940, tungsten ore was discovered by C. W. Fletcher, and early in 1941, the Pacific Tungsten Company leased the properties from Fletcher. Their operations are described by Tucker and Sampson.[98] The geology of these tungsten deposits is described by Wilson.[99] The ore was milled at the Keeler Gold Mines, Incorporated mill, which was converted by the West Coast Tungsten Company for tungsten concentration.[100]

Total tungsten production figures are not available, but Wilson [101] states that during the first year of operation 30,940 tons of ore was produced and that the ore milled was 1.0 percent WO_3.

During 1947 and 1948, V. C. Ryan and associates leased the properties for lead-silver ore. Some ore was mined and shipped during 1948.

The properties are idle.

Gold Bottom Mine (Copper Queen Group No. 2, Slate Range).[102] Location: On the west slope of the Slate Range about 6 airline miles northeast of Trona in sec. 31, T. 24 S., R. 44 E., M.D.M. (projected).

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[94] de Carbonel, W., private report, 1950.

[95] Tucker, W. B., and Sampson, R. J., op. cit., p. 439, 1938.

[96] Tucker, W. B., and Sampson, R. J., op. cit., p. 439, 1938.

[97] Kelley, V. C., op. cit., p. 561, 1938.

[98] Tucker, W. B., and Sampson, R. J., Recent developments in the tungsten resources of California: California Div. Mines Rept. 37, pp. 570-571, 1941.

[99] Wilson, L. Kenneth, Tungsten deposits of the Darwin Hills, Inyo County, California: Econ. Geol., vol. 38, no. 7, pp. 543-560, 1943.

[100] Tucker, W. B., and Sampson, R. J., op. cit., pp. 574-575, 1941.

[101] Wilson, F. Kenneth, op. cit., p. 544.

[102] Tucker, W. B., and Sampson, R. J., Current mining activity in southern California: California Div. Mines Rept. 36, p. 26, 1940.

Ownership: 6 patented claims and an unknown number of unpatented claims between this property and the Ophir Mine, are owned by Gold Bottom Mines, A. L. Damon, president, 2215 Poplar Avenue, Sacramento, California.

Replacement lenses of galena, oxidized lead, zinc, and iron minerals are along fissures which parallel the strike of the bedding and contact of the limestone with shale country rock. The trend of the fissures is N. 50° W. and the dip is 65° SW.; one fissure dips 35° to 45° NE. The oreshoots average about 200 feet in length and 5 feet in width.

The mine is worked by a series of adits as follows: Annex, elevation 2230; Marble Halls, elevation 2245; Mill, elevation 2298; Queen, elevation 2370; Truman, elevation 2480. Underground workings total more than 7500 feet.

The property was discovered in the 1880's and the upper orebodies were mined before 1900. After 1900 the lower orebodies were mined. The Gold Bottom Mines, Incorporated took over the property in 1935 and worked it intermittently. In 1943 A. L. Damon acquired control of the company and worked the mine briefly.

During 1936 and 1937 ore was shipped to the United States Smelting, Refining and Mining Company at Midvale, Utah. It averaged 0.63 ounce of gold, 14.5 ounces of silver, 15.9 percent lead, and 0.6 percent copper per ton. Concentrate from a 25-ton flotation plant averaged 0.91 ounce of gold, 21.5 ounces of silver per ton, and 20.3 percent lead and 0.75 percent copper. The value of ore produced during these two years totaled $25,000. Early-day shipments are reported to have contained 40 percent lead and 35 ounces of silver per ton. Some shipments after 1937 were made to the American Smelting and Refining Company at Selby, California. Total production has been between $900,000 and $1,000,000 worth of ore.

Equipment includes two gasoline-powered compressors with a combined capacity of 350 cubic feet per minute. The 25-ton mill 1½ miles west of the mine was operated only for a short time.

The property is idle.

Grand View Claims.[103] Location: Secs. 1, 2, 11 and 12, T. 19 S., R. 41 E., M.D.M., 2¼ miles south-southwest of Panamint Springs in the Argus Range. Ownership: 2 unpatented claims, Grand View and Grand View No. 2, are owned by Charles M. Heron, 465 N. Segovia, San Gabriel, California, and Allan Kempe, Ojai, California.

Lead ore, galena, and cerussite with some zinc, is associated with chert and has replaced limestone along bedding planes near a crosscutting fault. The limestone, generally massive but containing some thin, black limestone beds, strikes N. 65° E. and dips 45° NW.; the fault strikes N. 55° W. and dips 65° NE. On the southeast, the limestone is in contact with a granitic intrusive.

The claims have a 20-foot shaft, a small open cut and an adit, 100 feet in length. Seventy feet northeast of the shaft, a small cut exposed a 4-foot width of 12 percent lead ore at a depth of 8 feet. An adit 50 feet below the cut to the northwest was driven 100 feet to intersect this ore zone at that elevation and a 30-foot raise was driven in the fault area from the point of intersection. No ore was found.

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[103] Herron, Charles M., personal communication, 1950.

Exploration work was done by Herron and Kempe in 1948-49. All supplies and equipment were transported 2 miles by pack animals. The work was abandoned in 1949.

Honolulu-Big Horn Mine (Gibralter).[104] Location: 6 airline miles S. 43° E. of Ballarat in South Park Canyon, sec. 29 or 30, T. 22 S., R. 45 E., M.D.M. (projected). Ownership: 4 claims are owned by John Thorndyke, Trona, California.

The deposit was discovered in 1907 [105] and 25 cars of ore were shipped during the early operations. A part of this ore assayed 30 percent lead and 20 ounces of silver per ton.[106] Southwest Lead and Zinc Company, M. H. Evans, president, Los Angeles, operated the property from 1942 through 1944 and shipped approximately 1300 tons of ore containing 550,000 pounds of zinc, 350,000 pounds of lead and 5,000 ounces of silver. Ore was trucked to Trona and shipped to various smelters.

The ore consists of replacement bodies in limestone and dolomitic marble. Four principal veins have been worked.

Honolulu claim has a 400-foot adit which follows a poorly defined zone of zinc sulphide ore, ranging in width from a thin seam to three feet and assaying 50 percent zinc and 10 to 15 percent lead. Some of the ore was stoped from above the adit level and in one place, a 35-foot winze was sunk on rich ore.

Carbonate adit is 135 feet above the parallel Honolulu adit. The vein which it follows strikes northward, dips eastward, and ranges from 2 to 10 feet in width. The ore was principally zinc carbonate with some lead carbonate. Some offshoots from the main zone enlarged into pockets or ''rooms'' of residual lead carbonate. A hanging wall fault contains ore, and in many places zinc carbonate is disseminated through what appears to be barren limestone. Ore from these workings was handled through a raise driven from the Honolulu adit below.

Iron vein adit, 130 feet west and 50 feet vertically below the Honolulu adit, follows an irregular but well defined vein, 2 to 5 feet wide, for a distance of 100 feet. A conspicuous gossan marks the surface outcrop of the vein which can be traced for several hundred feet. Vein matter consists of gossan containing small amounts of zinc and lead carbonate. A small pocket of rich lead carbonate ore was mined from this adit.

Big Horn workings, one-half mile east of Honolulu claim, consist of an 80-foot inclined shaft and several drifts. The Big Horn vein crops out boldly, strikes eastward and dips 20°-30° S.; it ranges from a few inches to 7 feet in width. Ore consists of cerussite and fine-grained galena, and many samples assay 50 to 70 percent lead. West of the shaft the ore is of good grade; east of the shaft it becomes increasingly poorer until it is finally truncated by a north-striking, east-dipping fault.

Before 1924, when a road was built to the mine, ore was hauled by pack-train. A 2150-foot aerial tram was installed later to deliver ore from the workings to the end of the road at the Honolulu camp.

The property is idle.

Kerdell Lead Mine. Location: In T. 17 S., R. 43 E., M.D.M. (projected) south of the Cottonwood Canyon area of the Panamint Mountains; 16 miles by road and 4 miles by trail from Stovepipe Wells. Ownership: 12 unpatented claims owned by Gold Hill Dredging Company, 311 California Street, San Francisco, California.

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[104] Evans, M. Harrison, personal communication, 1950.

[105] Murphy, F. M., op. cit., p. 121, 1929.

[106] Waring, Clarence A., and Huguenin, Emile, op. cit., p. 95, 1919.

The deposit consists of replacement lenses of ore along joint planes in limestone. The principal ore mineral is galena with minor amounts of gold. Work was started in March 1949, according to the Company, and workings consist of two adits, with drifts, raises and winzes totaling 300 feet.

Five men are employed in development work. Supplies are packed in by trail.

Lead Mine (Hughes Group). Location: On the east slope of the Argus Range approximately in sec. 27, T. 19 S., R. 42 E., M.D.M. (projected), adjoining the Modoc mine on the north. Ownership: 4 claims are owned by Mason E. Franklin, 4599 Pacific Boulevard, Los Angeles, California.

Lead minerals, carrying silver and gold, are in replacement bodies in limestone. The property has a 160-foot nearly-vertical shaft from which drifts have been driven on three levels. Level workings total approximately 200 feet.

According to the owner, no ore has been produced since 1926 when ore valued at $45,000 was shipped. The property was leased by R. E. Major from the fall of 1946 to the spring of 1947; the shaft was deepened 60 feet and drifts were driven on the 100 and 160-foot levels. Some lenses of ore were found which assayed as high as 60 percent lead, 19 ounces of silver and from ½ to 2 ounces of gold per ton.[107]

The property is idle.

Lippincott Lead Mine (Lead King). Location: 4 miles south of Ubehebe Peak in sec. 13, T. 15 S., R. 40 E., M.D.M. (projected) and 32 miles by road south of Ubehebe Crater. Ownership: 12 unpatented claims are owned by George Lippincott, P. O. Box 1811, Santa Ana, operating the Lippincott Lead Company.

The Lippincott lead deposits, according to McAllister,[108] characteristically resemble pods and pipes in siliceous veins which cut Paleozoic dolomite, although some of the ore shoots have replaced the dolomite along minor faults and in brecciated zones. Galena and cerussite, the chief lead-ore minerals, are in a gangue of quartz and chalcedony. Zinc, in the minerals smithsonite and sphalerite, and silver disseminated through the galena are also recovered; contemporaneous deposits of copper, iron, tungsten, and talc were formed in the dolomite by the intrusion of a quartz monzonite stock, but are of low grade and have not been exploited.

The dolomite and overlying sedimentary rocks are folded into an inverted overturned syncline, which to the east becomes a fault. Another fault, nearly parallel to the western margin of the area, intersects a northwest-trending shear zone. Minor faults, trending north and northwest, are probably related to this shear zone and have controlled the lead deposits.

An adit, called the "main tunnel," was started 100 feet west of the camp at an altitude of 3750 feet, and was driven for a distance of 625 feet S. 45° W. A 50-foot drift was run southeast along a narrow mineralized seam 125 feet from the portal. About 250 feet from the portal, drifts 125 feet and 105 feet long have been driven northwestward and southeastward respectively. From the southeast drift, a pipelike orebody plunging N. 70° W. was mined to the surface; the orebody extends 200 feet or more down plunge and reaches a maximum diameter of 14 feet. A 60-foot winze was sunk below the tunnel level 30 feet southwest of the tunnel. Approximately 1000 tons of ore, mined from an orebody 6 inches to 14 feet wide and assaying 42 percent lead and 8 ounces silver, has been shipped from these workings.

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[107] Major, R. E., personal communication, June 1950.

[108] McAllister, James F., Geology of the Lippincott lead area, Inyo County, California: U. S. Geol. Survey, Prelim. Rept., September, 1949.

Confidence No. 2 tunnel, 800 feet S. 25° E. of the main tunnel at an altitude of 4000 feet, was driven S. 17° W. for a distance of 145 feet. Seventy-five feet from the portal, a 40-foot winze was sunk. Approximately 50 tons of ore was shipped from here. Johnson tunnel, started 200 feet S. 69° E. from Confidence No. 2 tunnel at the same altitude, was run S. 36° W. a distance of 240 feet for prospecting purposes.

The Taylor shaft, 50 feet west of the Johnson tunnel, is inclined 65° NW. It reached a depth of 135 feet following an orebody which averaged 2 feet in width. Four hundred tons of ore was shipped from the shaft and a raise; the assays of the ore showed a range of 17 to 40 percent lead. The maximum zinc and silver content was 20 percent and 105 ounces respectively. Lippincott states that the relationship of high silver to high zinc content is typical of the ore.

In the Addison shaft, started 775 feet southwest of the Confidence No. 2 tunnel at an elevation of 4900 feet, an orebody 125 feet long and inclined 40° NW. was mined.[109] Production from this orebody, 1 foot to 3 feet wide, amounted to $35,000 worth of ore; some shipments assayed as much as 63 percent lead and 36 ounces of silver per ton.

The value of 2000 tons of ore produced to date from the mine was $80,000. Assays of the shipments showed the quality of the ore to range as follows: 25-40 percent lead, 11-38 ounces silver, and 4-11 percent zinc. The inaccessibility of the mine has made it unprofitable to ship lower-grade ore. At present, all ore is treated at the Lippincott Lead Company smelter at Santa Ana, California. Previously, a considerable amount of the ore was shipped to other smelters and custom plants.

Equipment at the mine includes one 250 and one 135 cubic feet per minute diesel compressors, a D-4 Caterpillar bulldozer, diesel light plant and modern camp facilities. The nearby Racetrack plaza is utilized as a landing field for airplanes. Three men are employed.

Mexican Mine (Reed Flat Mine). Location: On the western slope of the White Mountains in sec. 6, T. 7 S., R. 35 E., M.D.M. at an altitude between 10,000 and 10,500 feet, about 12 airline miles east of Bishop. Ownership: 6 unpatented claims are owned by Ward McEntyre, Jim Burchim, and Frank Watkins all of Bishop, California, and H. M. Brown of Big Pine, California.

The Reed Flat Mine was originally located in 1862, but was abandoned and relocated several times before the present filing in 1942. In 1926, an option on the property was taken by the Mexican Mining Company of Virginia City, Nevada, and the mine became known as the Mexican mine.

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[109] McAllister, James F., op. cit.

Galena and lead and zinc carbonates occur in a poorly defined, northeast-trending zone of replacement in limestone. The mine has several open cuts, in one of which is a 60-foot shaft, and an 800-foot crosscut adit driven approximately S. 60° E. More than 400 feet of drifts and crosscuts are driven to the north from this adit, as well as a 60-foot winze and a 25-foot raise. Samples taken underground in 1948 assayed from a trace to 3.7 percent lead, 1.2 to 6.0 percent zinc and 0.42 to 2.60 ounces of silver per ton. No production records are available.

The property is leased to the E. M. Rose and Company, Incorporated, 544 N. Hunter Street, Stockton, California.

Minietta Mine.[110] Location: On the east slope of the Argus Range in secs. 33, 34, T. 19 S., R. 42 E., M.D.M. (projected) about 9 airline miles southeast of Panamint Springs. Ownership: 5 claims and a millsite owned by Mrs. Jack Gunn, Independence, California are leased to David D. Baker, Ross Finley and Tom Vignich, Panamint Springs, California.

The ore is principally argentiferous galena in fissures and bedding planes in limestone. Work by the present lessees has been on the St. Charles claim. Here the ore strikes N. 40° to 45° E. and the dip, which is 45° NW. at the surface, flattens to approximately 22° NW. in the lower adit.

The mine consists of three levels. On the upper level, the ore has been stoped from an 85-foot drift to the surface. The middle level consists of a 65-foot adit. The lower level is a 250-foot adit from which raises and crosscuts have been driven. Total work by the present lessees is approximately 350 feet. By April 1949, 26 cars (over 1700 tons) of ore, averaging 16 percent lead, had been shipped, according to Finley.

In April 1949 a mill was in operation treating the tailings from the old mill. The tailings are pulled over a $\frac{3}{4}$-inch wooden grizzly into a bin by a scraper and a double-drum gasoline-motor-powered hoist. From this storage bin, the tailings are transferred by a bucket elevator to a trommel where minus $\frac{1}{16}$-inch material passes into four cones for water classification. The cones are 12, 18, 36 and 72 inches in diameter and the overflow from each is treated on a separate 4 by 12-foot Dunham Economy table. The tables are all belt-driven by a Ford Model-A motor. Capacity of the mill is $1\frac{1}{2}$ tons per hour.

Water for all purposes is provided by springs in Thompson Canyon and flows by gravity through 2 to $2\frac{1}{2}$ miles of 2- and $1\frac{1}{2}$-inch pipe. Equipment includes a portable Ingersoll Rand compressor of 300-cubic-foot capacity.

Five men, including Finley and Vignich, are working.

Modoc Mine. Location: On the east slope of the Argus Range about $8\frac{1}{2}$ airline miles southeast of Panamint Springs, in secs. 27, 28, T. 19 S., R. 42 E., M.D.M. (projected). Ownership: The Hearst Estate, San Francisco, California owns 5 patented claims, the Modoc, Confidence, Lookout, Keyes, and Hearst, and 3 unpatented claims, the Colorado, Delta, and Valley View.

The deposit and mine workings are fully described by Tucker and Sampson.[111]

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[110] Tucker, W. B., and Sampson, R. J., op. cit., p. 445, 1938.

[111] Tucker, W. B., and Sampson, R. J., op. cit., pp. 445-447, 1938.

No additional work was done on the property until 1944 when L. D. Foreman and Company, Salt Lake City, Utah, started shipping ore from slag and mine dumps. Smelter reports on these shipments show the following:

Slag dump	
lead	6.22—10.00 percent
zinc	7.60—10.00 percent
silver	2.45— 4.80 ounces
Mine dump	
lead	2.37—11.07 percent
zinc	4.00— 5.20 percent
silver	6.80—12.83 ounces
gold	0.03— 0.12 ounces

Total shipments are estimated at 15,000 tons, most of which was slag dump material. In 1947, an exploratory drift was started from the No. 2 tunnel, but no ore was found.

The property is idle.

New Sutherland Divide Mining Company (Carbonate, Queen of Sheba).[112] Location: 37 airline miles west of Shoshone on the east slope of the Panamint Range in sec. 20 (?), T. 22 N., R. 1 E., S.B.M. (projected). Ownership: New Sutherland Divide Mining Company, Henry Grivi, secretary, 1017 Garfield Building, 403 W. 8th Street, Los Angeles, California, holds 9 unpatented claims, including the Carbonate and Queen of Sheba Mines.

The Queen of Sheba claim was originally worked by a 1000-foot adit and several crosscuts. Upon resumption of work by the New Sutherland Divide Mining Company in 1944, an examination was made which included extensive sampling. Reopening of the mine was done by three 100-foot crosscut adits with numerous drifts, and rises totaling 2500 feet were driven at 50-foot vertical intervals. The replacement-type orebody is in dolomite which strikes northeastward and dips steeply to the east. A large tonnage of ore assaying 7 percent lead and 5 to 10 ounces of silver per ton was available in the Queen of Sheba workings in 1948, but shipments of concentrates were small.

The Carbonate mine, worked by a series of adits to a vertical depth of 150 feet, was reopened in 1948 and concentrates from the ore assayed 35 to 40 percent lead. The orebodies here are replacement lenses in dolomite which trends north-northwestward and dips 35° E. The ore mineral is principally lead carbonate associated with galena, silver, and gold.

A new flotation mill, erected in 1947-1948, was designed to treat 100 tons of ore per day. The original flow sheet showed a 10- by 20-inch jaw crusher, 5- by 7½-foot Marcy ball mill, Bendelari jig, classifier, agitators, flotation cells, concentrating tables and a disc-type filter. Power is supplied by a 250-kw General Electric, diesel-powered generator. Water was pumped from a well in the floor of Death Valley for a distance of four miles against an 1150-foot hydraulic head.

The property is now idle, as operations ceased in mid-1949.

Nopah Group. Location: At the north end of the Nopah Range in sec. 5, T. 23 N., R. 8 E., S.B.M. (projected). Ownership: 4 claims are owned by J. P. Madison, Shoshone, California.

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[112] Tucker, W. B., and Sampson, R. J., op. cit., p. 430, 1938.

Lead and zinc minerals occur along a highly curved fault in a brecciated zone (a breccia pipe) which crosscuts the bedding of dolomitic limestone. The breccia consists of angular dolomitic limestone fragments in a greenish matrix.

The main workings consist of an 80-foot shaft inclined 80° E. from an open cut, with a 75-foot adit connection from the south to the shaft collar in the cut, and levels at 20 and 32 feet. On the 20-foot level, 75 feet of drift follows the curved fault for nearly 250 degrees. On the 32-foot level, 25 feet of drift follows the fault for 90 degrees. Some stoping has been done.

Five cars of ore, three of lead and two of zinc, were shipped by Madison in 1943. Madison reports the shipments averaged 30 percent lead and 30 percent zinc respectively. Silver in the lead ore was as much as 72 ounces per ton but averaged 17 ounces per ton.

The mine is idle.

Old Timer Mine. Location: About 6½ airline miles southeast of Keeler in sec. 29, T. 17 S., R. 39 E., M.D.M. (projected). Ownership: 6 claims are owned jointly by Charles Meyson and E. F. Fitzgerald, Lone Pine, California, and Julia Overgard, Oakland, California. An adjoining claim, the Trey of Diamonds, is owned by C. W. James, Lone Pine, California.

Argentiferous lead minerals are in a series of quartz veins which strike N. 45° W. and dip 60° SE. in blocky slate. Workings consist of a 90-foot adit from which a 58-foot winze has been sunk. At the bottom of the winze there is a 165-foot drift and a 65-foot raise driven from this drift. This work was reported by C. W. James who operated the property under lease from September 1947 to April 1948. He also reported a production of 36½ tons of ore with smelter assays of 9.42 ounces of silver per ton and 11.4 percent lead.

The property is now idle.

Ophir Mine.[113] Location: On the west slope of the Slate Range about 7 airline miles northeast of Trona, approximately in sec. 24, T. 24 S., R. 43 E., M.D.M. (projected). Ownership: 2 patented and 13 unpatented lode claims are owned by Gold Bottom Mines, A. L. Damon, president, 2215 Poplar Avenue, Sacramento, California.

The ore is galena, lead carbonate, and lead vanadate in a fissure zone which strikes N. 30° W. and dips 60° to 70° W. The workings consist of three shafts, the main one being 500 feet in depth, and more than 2500 feet of drifts and crosscuts.

The Thompson Divide Mining Company (now Gold Bottom Mines) took over the property in 1943. A new Allis Chalmers hoist with a 50 HP electric motor was installed, and 50 tons of ore per week was mined and shipped to the United States Smelting, Refining and Mining Company smelter at Midvale, Utah. The ore is reported to have averaged 20 percent lead, 4 percent zinc and 4 ounces of silver per ton. Reserves were not developed and the company stopped operations in July 1946 because of lack of ore and the difficulty of obtaining men. Some additional work was done in 1948 and early 1949. About 150 tons of ore was produced which assayed 8 percent lead, 10 ounces of silver and 0.04 ounces of gold.[114]

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[113] Tucker, W. B., and Sampson, R. J., op. cit., p. 450, 1938.
[114] Damon, A. L., personal communication, 1950.

Equipment in addition to the hoist included a 315-cubic-foot Ingersoll Rand compressor and electric motors in the mill. The mill had a capacity of 120 tons per 24 hours but was operated only 30 days per year. Power was supplied by the Southern Sierras Power Company.

The property is idle.

Panamint Mines. Location: 30 miles N. 33° E. of Trona in Surprise Canyon at Panamint City in the Panamint Range, T. 21 S., R. 45 E., M.D.M. Ownership: Mrs. Hedvig Meyers, 6827 Haywood Street, Tujunga, California and Ruby A. Teis, care of Foster T. Manoch, 912 Pershing Square Building, Los Angeles, California, own 95 percent and 5 percent interests respectively in the Alabama, Hemlock, East Hemlock and High Silver patented claims and the unpatented East Hemlock and High Silver millsites.

These two persons and William and Myrtle Greenwood, Sweet Springs, Missouri, own 45 percent, 5 percent and 50 percent interests respectively in the Challenge, Comstock, Eureka, Hudson River, Marvel, Stewart's Wonder, Wyoming, Star, Little Chief, Independence, Ida, and Panamint Central (Lewis Tunnel) patented claims, the Stewart's Wonder, Challenge, Little Chief, and Wyoming patented millsites, and 4 unpatented claims.

Ore deposits of the Panamint district have been described in various reports.[115]

American Silver Corporation had a lease on these claims in 1947-48 and did some work.

Tungsten minerals are on the Stewart's Wonder, Challenge and other claims.

The property is idle.

Perry Lead Mine. Location: At the northwest end of Panamint Valley in sec. 30, T. 17 S., R. 42 E., M.D.M. (projected) at an altitude of 2600 feet. Ownership: 1 unpatented claim is owned by Mrs. Agnes Reid, Panamint Springs, California.

Lead and zinc minerals are in a flat-lying deposit in gray dolomitic limestone near a flat-lying fault. Blue limestone, volcanic flows and intrusive rocks underlie the deposit.

The property was originally located in 1907 and a 640-foot tunnel was driven. In 1942 it was relocated by W. A. Reid, who leased it late in 1942 to Elmer Perry who drove three short tunnels and did some surface prospecting. No ore was mined.

The property is idle.

Red Cloud Mine. Location: 2 miles southeast of the Ratcliff Mine in the Middle Park area of the Panamint Range, in the approximate center of T. 22 S., R. 45 E., M.D.M. (projected). Ownership: 18 unpatented claims are owned by Harry Briggs, Trona, California.

Replacement bodies of lead-zinc ore are in fractures in limestone for a distance of 600 to 700 feet, according to the owner. The mine is worked by a 50-foot shaft from which 75 feet of drifts and crosscuts have been run south and southeast of the shaft bottom.

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[115] Murphy, F. M., op. cit., pp. 305-325, 1930.
Murphy, F. M., op. cit., 1929.
Murphy, F. M., op. cit., pp. 329-356, 1932.
Sampson, R. J., op. cit., pp. 359-364, 1932.
Tucker, W. Burling, op. cit., p. 495, 1926.
Jenkins, Olaf P., Tabulation of tungsten deposits of California: California Div. Mines Rept. 38, p. 324, 1942.

Fifty tons of ore was shipped in 1949, the assay of which showed 18 percent lead, 22 percent zinc and minor amounts of gold and silver.

The property was idle in February 1950 because of adverse weather and snow conditions.

Red Eagle Group (Blue Bird Group).[116] Location: Warm Spring Canyon, on the southwest slope of Gold Hill. Ownership: 6 unpatented claims are owned by Louise Grantham, 809 E. 6th Street, Ontario, California.

The deposit consists of a mineralized fault zone which strikes N. 20° W. and dips 70° NE. between blocky limestone (footwall) and shale (hanging wall). The ore is in silicified fault breccia and limestone. A 50-foot shaft, an open cut, and a 100-foot adit comprise the workings.

Assays of some ore showed 34 percent lead, 6 ounces of silver, and small amounts of gold.

The property is idle.

Royal Group (Cerro Gordo Extension, Spear).[117] Location: In the Inyo Range adjoining the Cerro Gordo Mines group on the north in secs. 11, 12, 13, 14, T. 16 S., R. 38 E., M.D.M. (projected) at an altitude of 9100 feet. Ownership: 30 unpatented claims are owned by the Silver Spear Mining Corporation, George Merritt, president, Santa Barbara, California, C. L. Hughes, vice-president, Los Angeles, California.

Three parallel veins strike N. 30° W. and dip 70° W. in limestone and range from 1 foot to 3 feet in width. The ore minerals are lead and zinc carbonates and galena containing gold and silver. Principal development work has been done on the Lead Queen claim and consists of a 70-degree inclined shaft 200 feet deep with levels at 50, 100 and 200 feet. On the 100-foot level, a 50-foot winze has been sunk on the south drift 100 feet from the shaft. A 75-foot drift was driven from the bottom of the winze. Level workings from this shaft total approximately 900 feet.

Total production is reported [118] to be $30,000 worth of ore. The property was last operated in 1940.

Santa Rosa Mine. Location: 10 airline miles southeast of Keeler in secs. 26 and 35, T. 17 S., R. 39 E., M.D.M. Ownership: 6 patented claims and a millsite are owned by Santa Rosa Mining Company, J. R. LeCyr, president, Box 116, Keeler, California.

A series of parallel fissure veins and minor replacement zones, striking N. 17° W. and with an average dip of 45° W., are in quartzites, argillites, and limestone. Galena and its oxidation products with varying amounts of silver are the predominant ore minerals. The geology and mine workings have been described by Tucker and Sampson.[119]

Lessees have produced a small amount of ore since 1938. In 1948 and 1949, 12 cars of ore averaging 15 percent lead and 6 ounces of silver per ton were mined and shipped. During 1947 and 1948 Louis Warnken,

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[116] Information from private report furnished by owner.
[117] Tucker, W. B., and Sampson, R. J., op. cit., pp. 433, 434, 1938.
[118] Hughes, C. L., oral report, 1950.
[119] Tucker, W. B., and Sampson, R. J., op. cit., pp. 453-454, 1938.

Jr. of Darwin shipped 12,000 tons of dump material assaying 5.7 percent lead and 3.4 ounces silver per ton.

The property was idle in February 1950.

Shoshone Mines (Includes the Alexander, Apex Consolidated Group, Black Prince, Columbia No. 2, Grant, Gunsight, Mabel, Noonday, Oro Fino, Rainbow, and War Eagle Mines). Location: About 7 miles east of Tecopa in secs. 9, 10, 14, 15, 16, 22, 23 and 27, T. 20 N., R. 8 E., S.B.M. (projected), and some claims in T. 19 N., R. 8 E., S.B.M. (projected). Ownership: Anaconda Copper Mining Company, 25 Broadway, New York 4, New York, William H. Hoover, president, owns 18 patented and 41 unpatented mining claims and several millsites. S. K. Droubay, manager, Frank Bâby, superintendent, E. C. Peterson, mill superintendent.

The Tecopa Consolidated Mining Company of Los Angeles gained control of the principal mines of this group before 1912. Production by this company for the period 1912 to 1928 was $3,000,000 worth of lead and silver. After 1938, the property was purchased by Shoshone Mines, Incorporated, and in May 1945 by the Finley Company (Shoshone Division). On June 1, 1947 Anaconda Copper Mining Company purchased the mines.

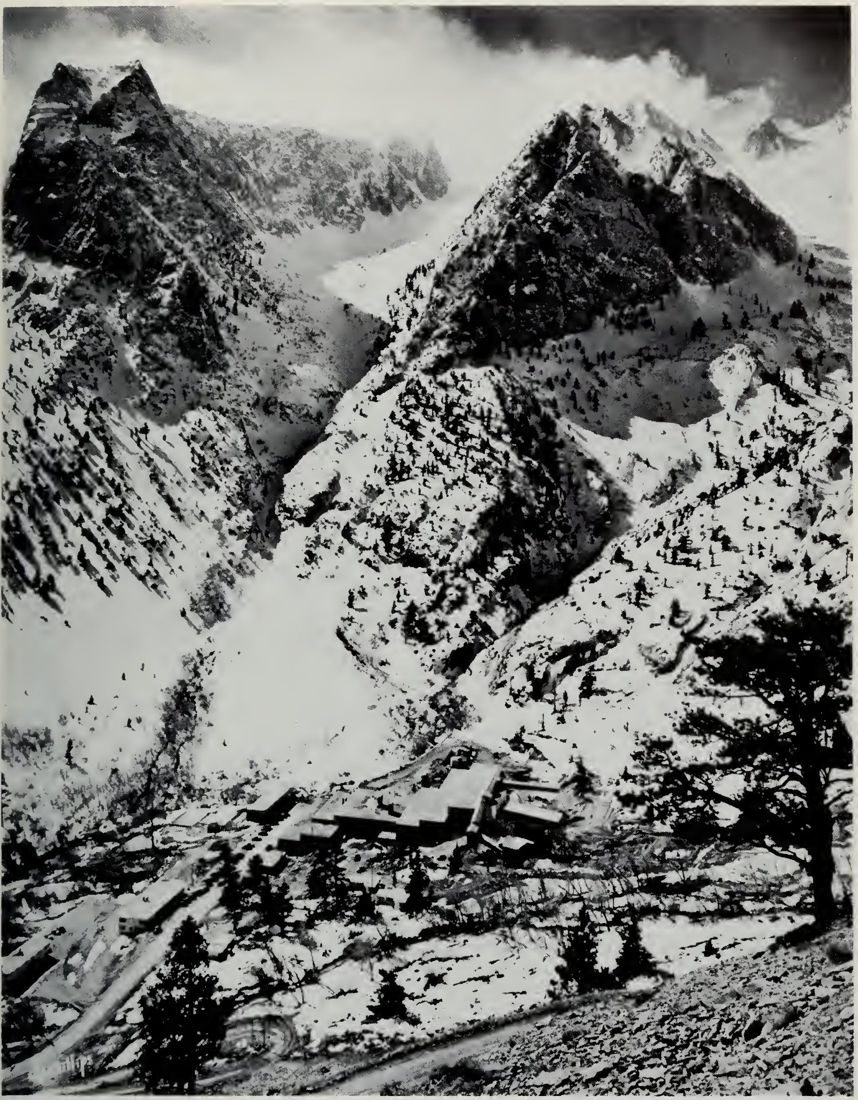
The orebodies are replacements and fissure fillings in a fault zone which strikes N. 10° to 45° W. and dips 30° to 60° NE. The main vein on the War Eagle strikes north and dips 35° E. The country rock is the Noonday dolomite. Mineralization has probably been controlled in part by a series of cross fractures and faults which strike north and are steeply dipping or vertical. Argentiferous galena was the primary ore mineral, but oxidation has produced cerussite and anglesite.

The Anaconda operations have been concentrated on the Columbia No. 2 and the War Eagle mines. The Columbia No. 2 has a 765-foot shaft inclined at 36 degrees and a 200-foot inclined winze which was sunk from the bottom of the shaft. Lateral workings total several thousand feet. The blocked-out ore was mined out by September 1948, but prospecting continued, and the 765-level was extended to the north and west to explore an area indicated as favorable by diamond drilling.

The War Eagle, which is now the most important producing mine of the group, is worked by a 500-foot crosscut adit that intersects the vein on what is called the 250 level. From this point a 45-degree inclined shaft extends to the 350 level and then continues at 32½ degrees to the 500 and 600 levels. Lateral workings are extensive.

The main vein on the War Eagle has been offset by a fault striking N. 67° W. and dipping 32° SW. Work done during 1948 and 1949 disclosed good ore in the faulted portion of the vein on the 500 level. The grade of this ore runs from 20 to 40 percent lead, up to one-half ounce of silver for each percent of lead, and some gold. This ore shoot was found to be continuous down to the 690 level.

The mill (figs. 7-9) is a flotation plant with a capacity of 100 tons per day. The normal operating rate, however, is 75 to 85 tons per day. The mill was shut down in September 1948 but was started again in July 1949 after the faulted segment of the War Eagle vein was discovered on the 500 level. Mill concentrates and shipping-grade ore are hauled by truck to Dunn on the Union Pacific Railroad for shipment to the International Smelting and Refining Company plant at Tooele, Utah.

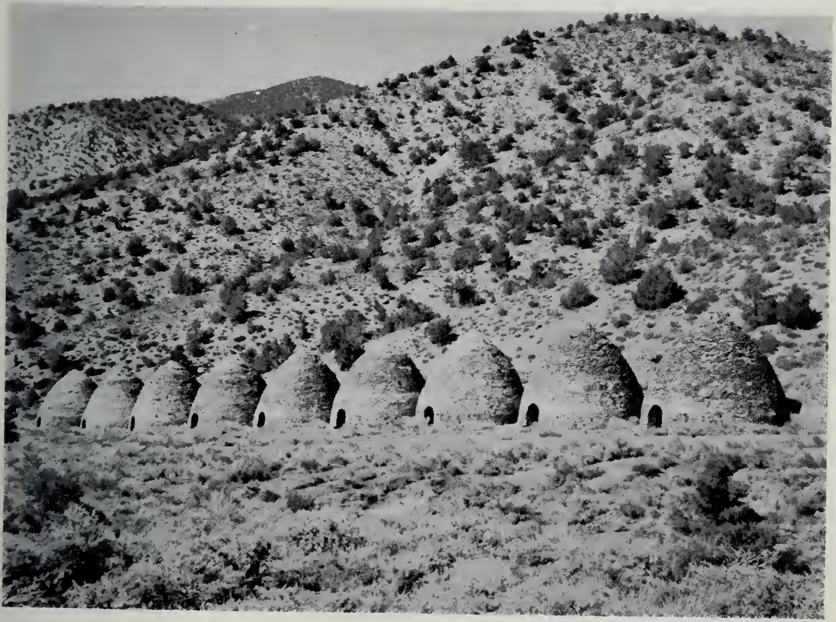


MILL AT PINE CREEK MINE
United States Vanadium Corporation. *Reproduced by permission of copyright owner, Curtis Phillips.*

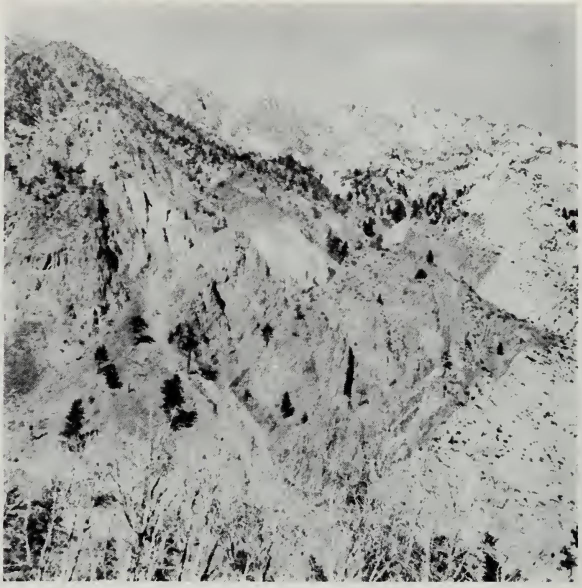
A. DARWIN MINES
Showing portal area of Radiore Tunnel, shops, and mill.
Photo courtesy Anaconda Copper Mining Company.

B. DARWIN HILLS
Viewed from south, showing town of Darwin, right-center, and Darwin Mines camp in center along base of hills.
Photo courtesy Anaconda Copper Mining Company.

A. WEST SLOPE OF PANAMINT RANGE
North of Highway 190, near Panamint Springs.

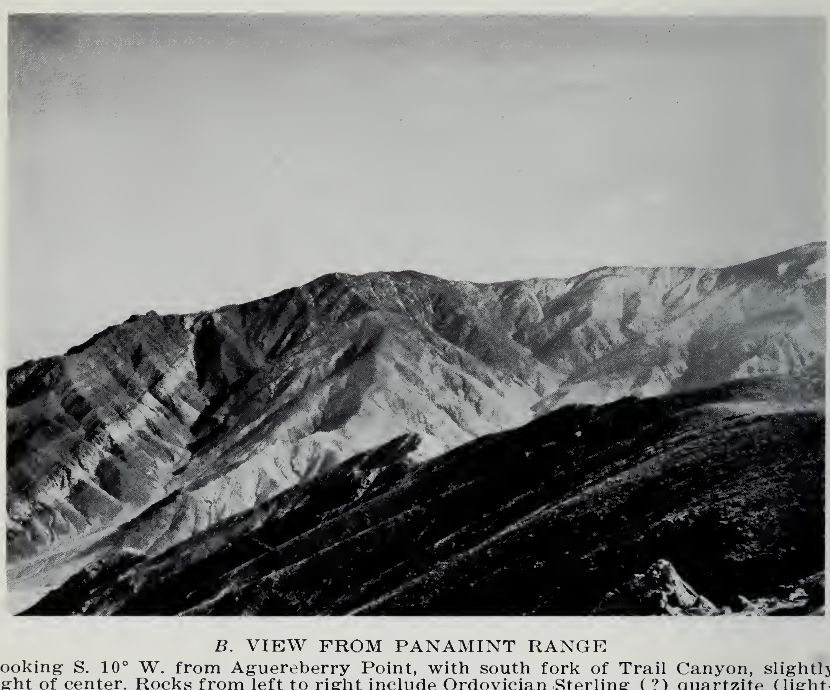


B. CHARCOAL KILNS
Wildrose Canyon, Panamint Mountains. Charcoal made here was used by early-day smelters in Inyo County.



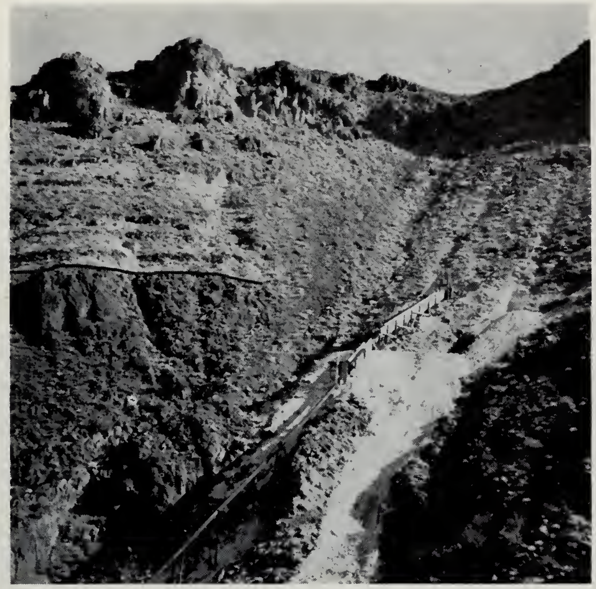
A. PINE CREEK PENDANT

Showing north contact with granitic rocks. Note the synclinal structure in pendant. Pine Creek, east slope of Sierra Nevada.

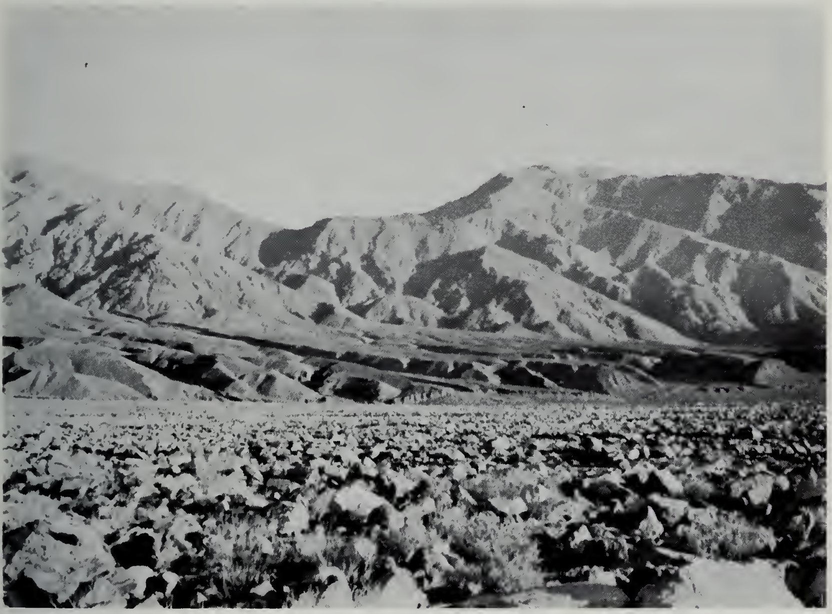


B. VIEW FROM PANAMINT RANGE

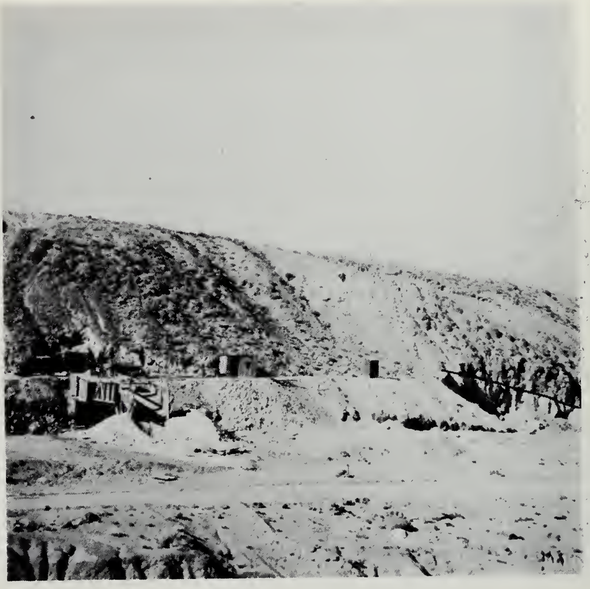
Looking S. 10° W. from Aguereberry Point, with south fork of Trail Canyon, slightly right of center. Rocks from left to right include Ordovician Sterling (?) quartzite (light-colored band at left) and Wood Canyon formations, and pre-Cambrian (extreme right).



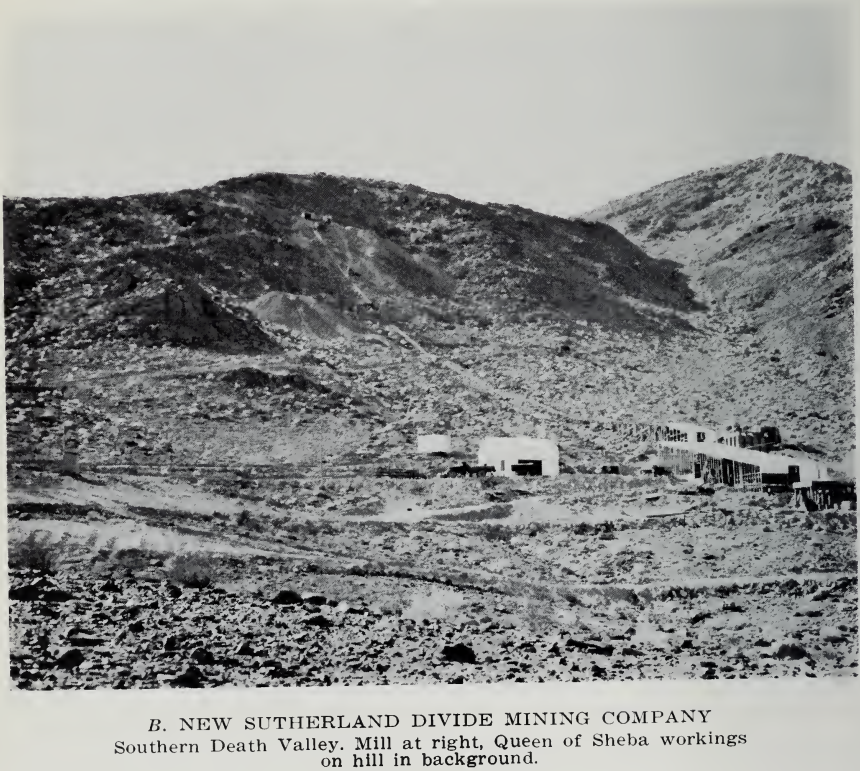
A. DEATH VALLEY TALC MINE
Talc outcrop in contact with diabase sill shown at left of center.



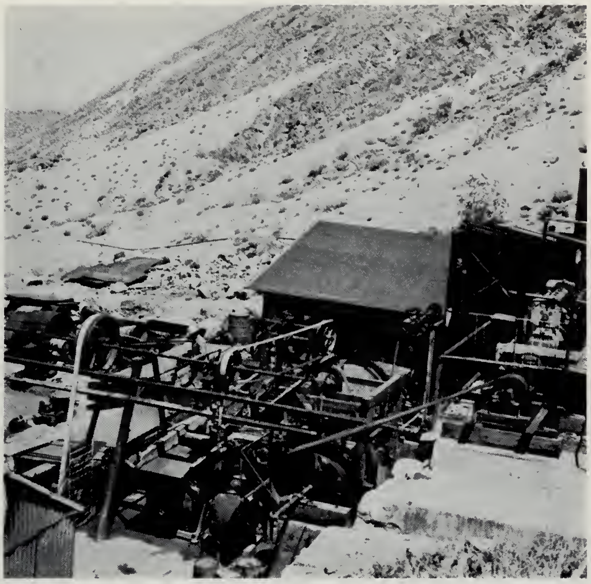
B. TRUNCATED ALLUVIAL FAN
West slope of Black Mountains in Death Valley.



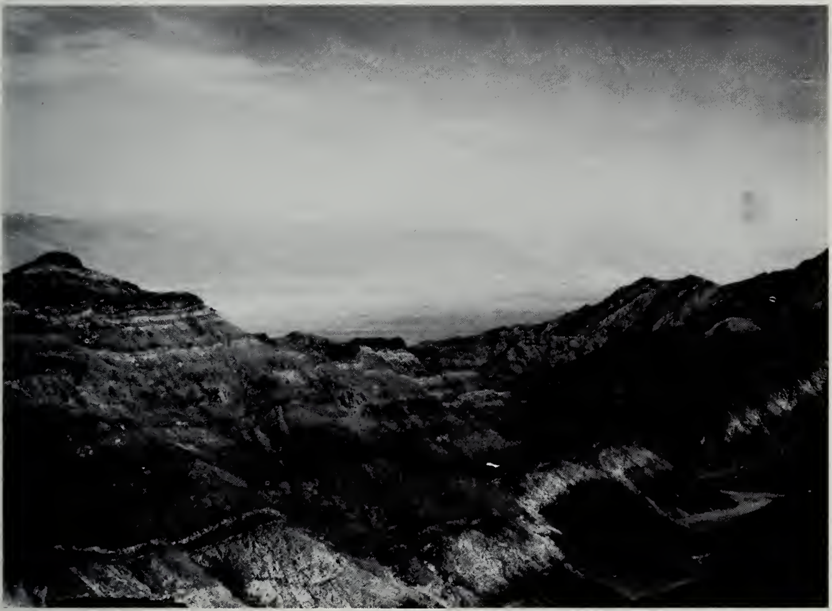
A. CALEARTH CLAY DEPOSIT
Portal of main haulage adit. Note gentle dip of clay bed at right.



B. NEW SUTHERLAND DIVIDE MINING COMPANY
Southern Death Valley. Mill at right, Queen of Sheba workings on hill in background.



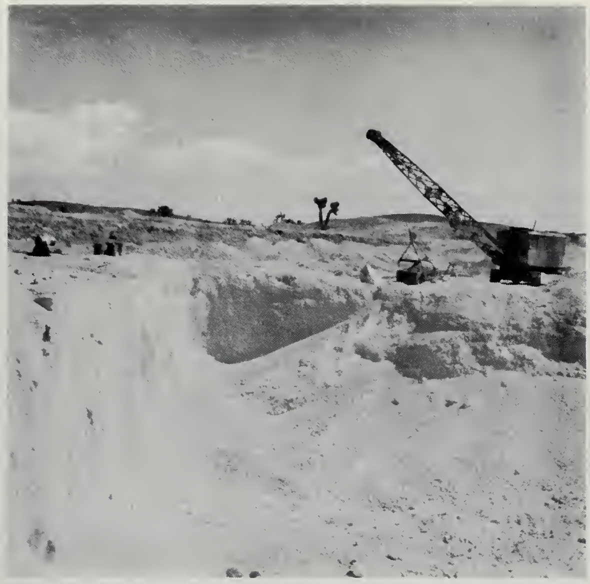
A. REWARD MINE MILL



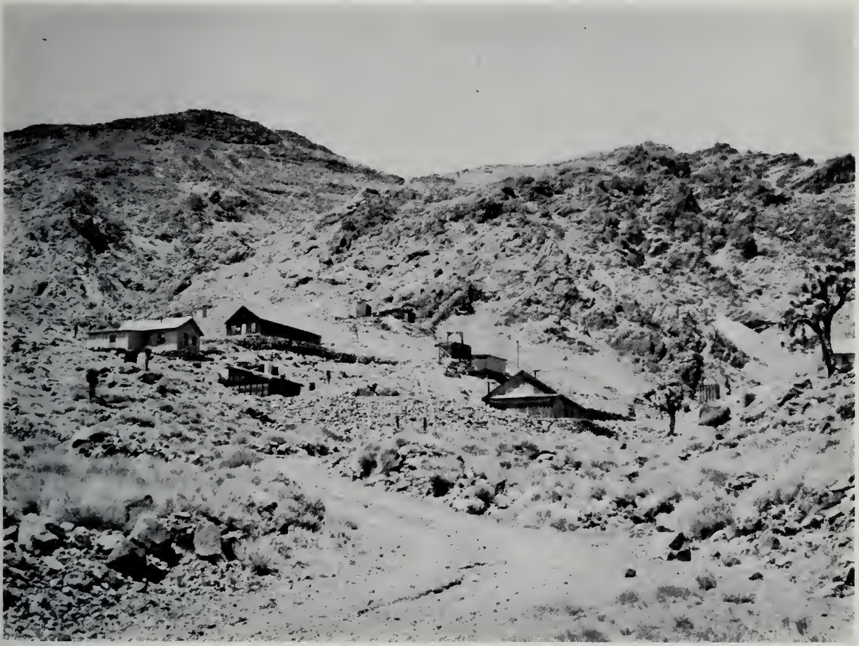
B. DEATH VALLEY AND AMARGOSA RANGE
Looking S. 28° E. from Aguereberry Point, Panamint Range.
Ordovician, Sterling (?) quartzite and Wood Canyon
formations in foreground, from left to right.

A. TALC CITY MINE. MORNING STAR SHAFT AREA

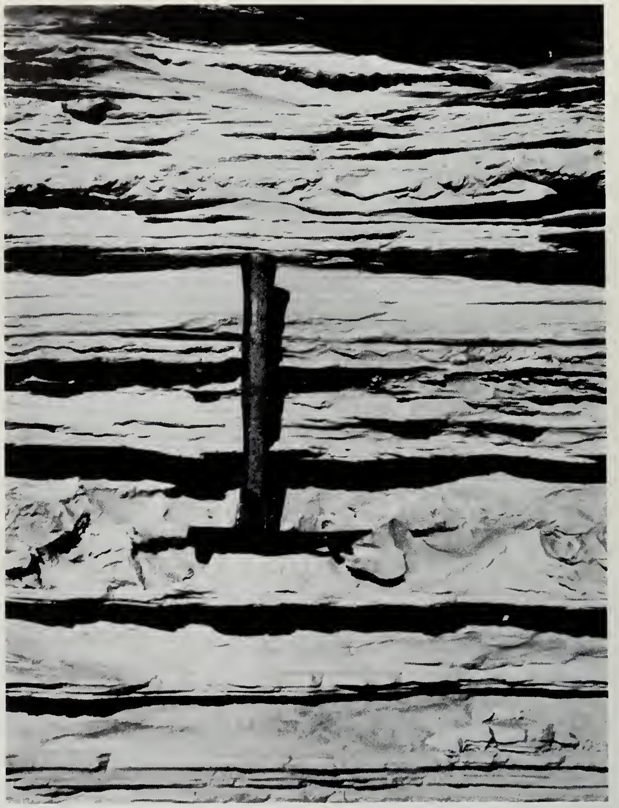
B. OLD DEPENDABLE ANTIMONY MINE
South fork, Trail Canyon, Panamint Range.



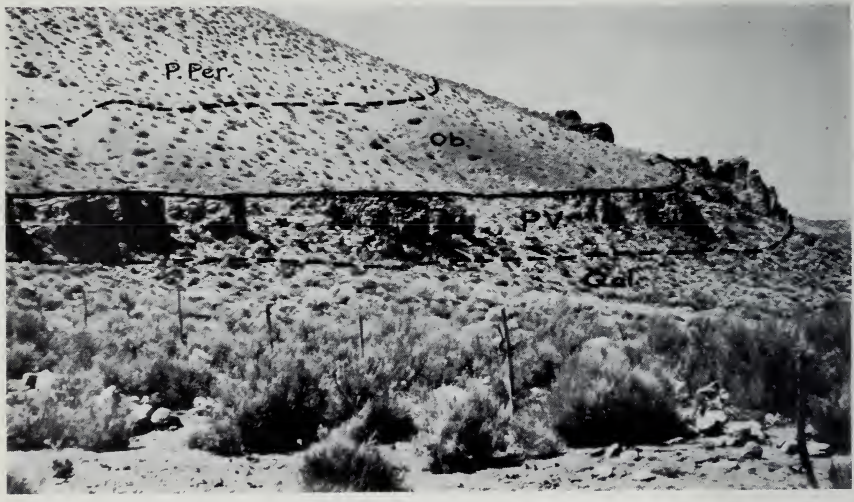
A. DESERT MATERIALS CORPORATION
Mining operations with dragline on Ray Gill No. 31 claim.



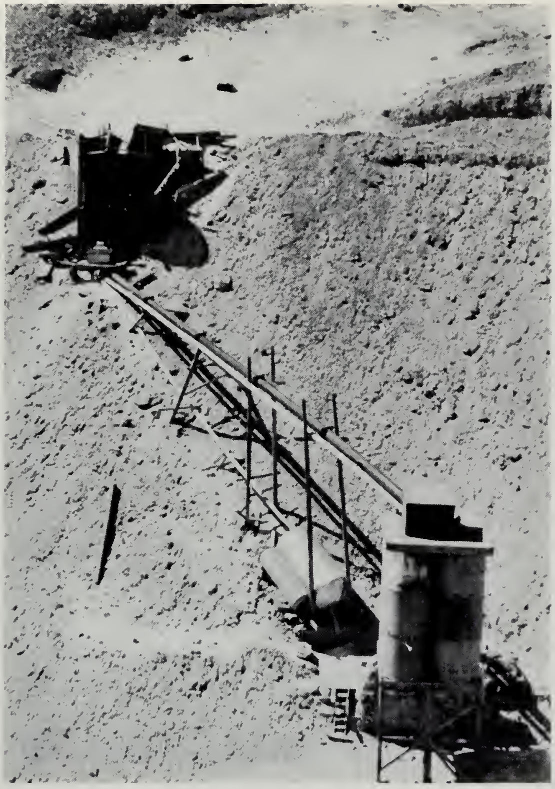
B. SANTA ROSA MINE, EAST SLOPE OF INYO MOUNTAINS



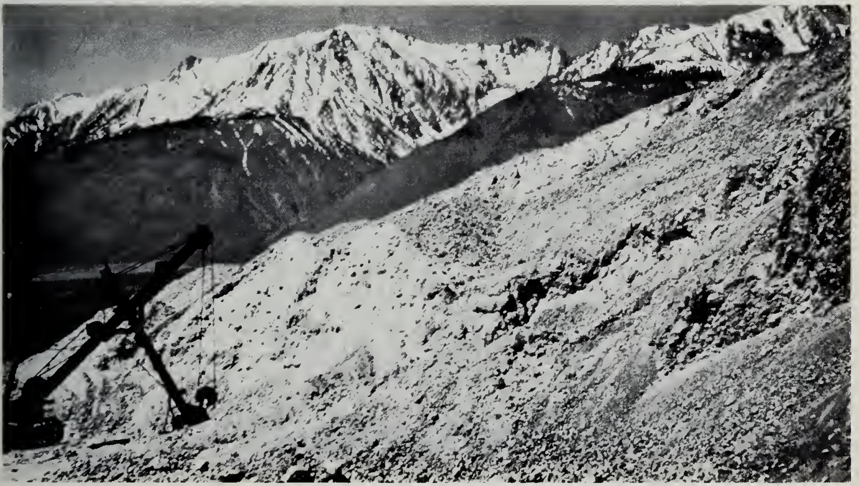
A. SHOSHONE PUMICITE "VOLCANIC ASH"
Note thin bedding and contorted nature of several prominent zones.
Length of pick handle is 12 inches.
Photo by C. W. Chesterman.



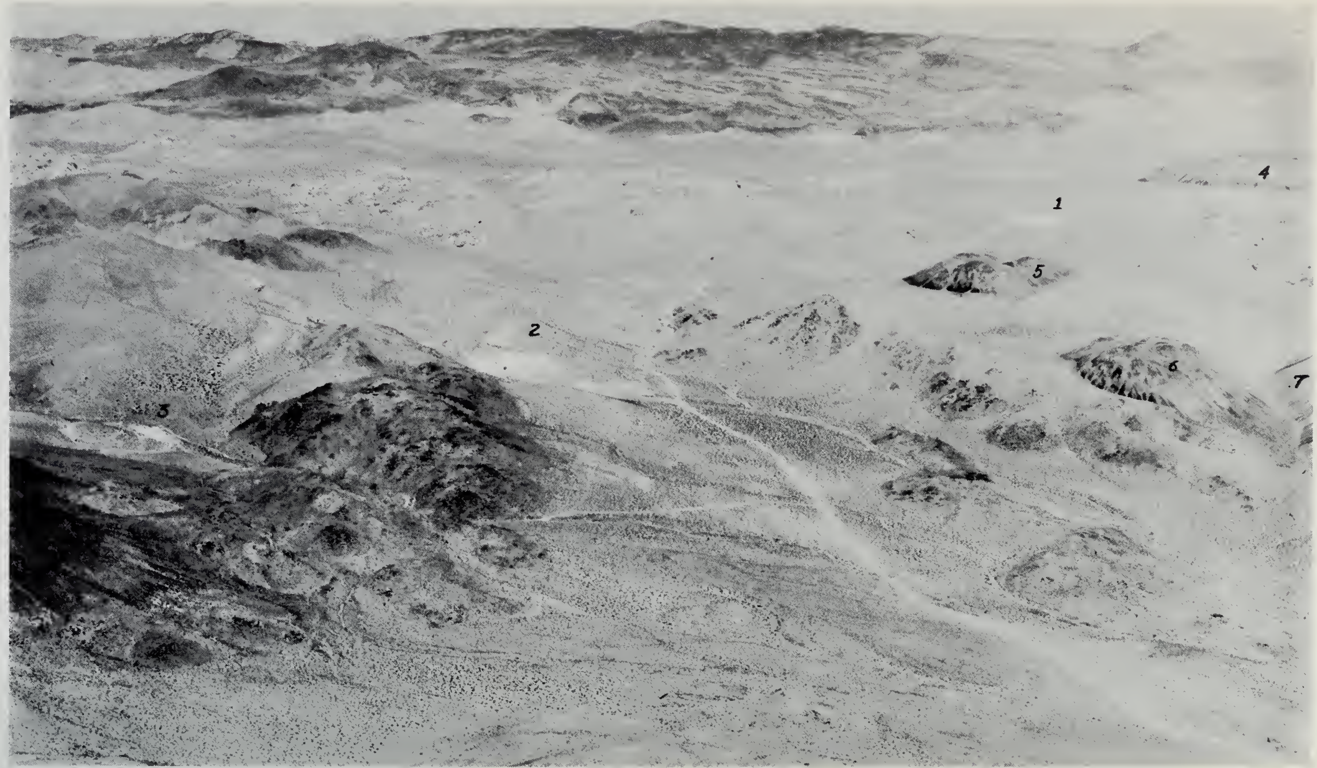
B. FISH SPRINGS PERLITE
Eastern end of hill showing sequence of volcanic rocks exposed: PV is a massive, platy perlitic vitrophyre which grades locally into rhyolite and perlite, and which rests upon alluvium; Ob is a brecciated obsidian in a pumiceous matrix; P. Per. is pumiceous perlite which grades downward into the brecciated obsidian. All of the perlite rock mined is from pumiceous perlite. *Photo by C. W. Chesterman.*



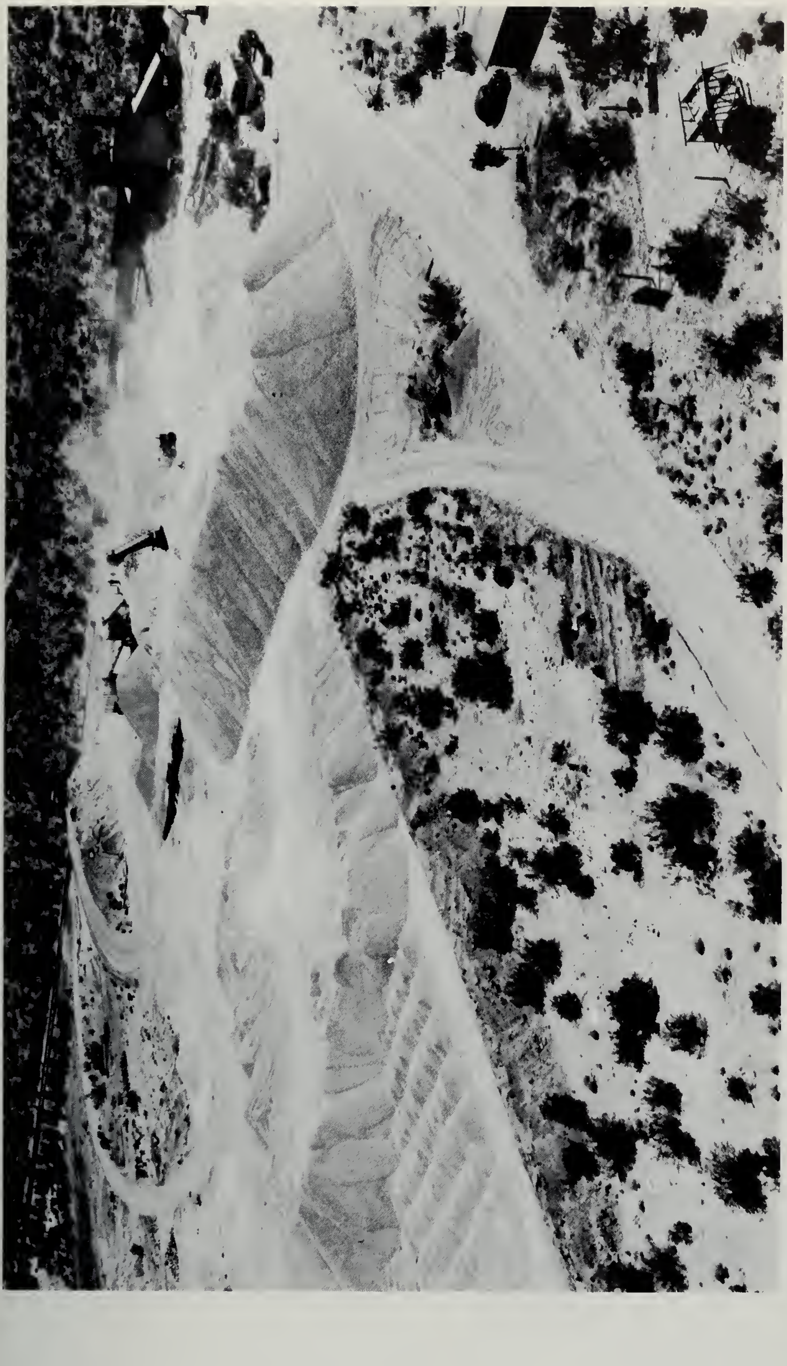
A. JAMIESON PUMICE PIT AND SCREENING PLANT
Photo by C. W. Chesterman.



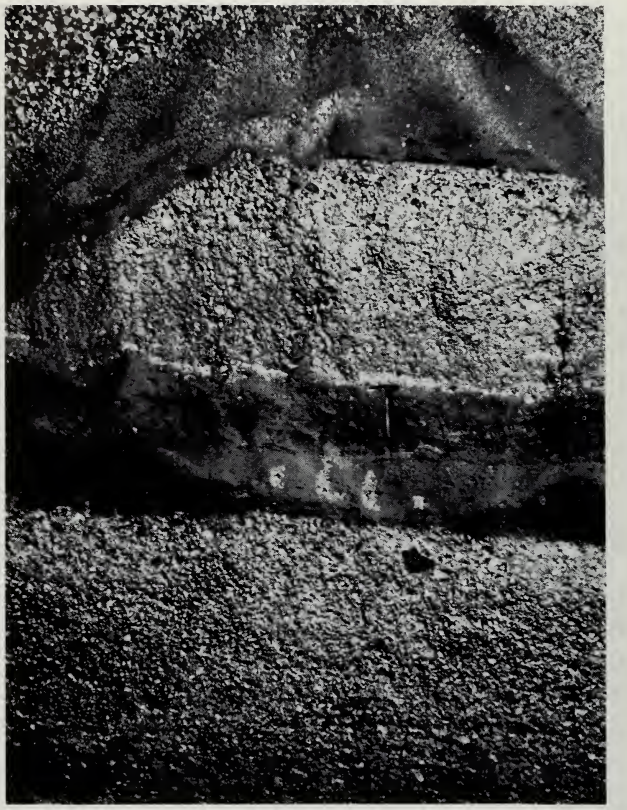
B. QUARRYING PUMICEOUS PERLITE
At Fish Springs Perlite. Sierra Nevada in background. Perlite rock quarried from this deposit is trucked to Loco where it is ground and screened.
Photo by C. W. Chesterman.



VIEW OF SOUTHERN COSO RANGE
Showing several pumice pits of the Desert Materials Corporation and a few of the perlite deposits "Domes". 1—Ray Gill #31 Pumice, 2—Ray Gill #13 Pumice, 3—Ray Gill #7 Pumice, 4, 5, 6, and 7 are perlite domes. *Photo courtesy of Whites Studios.*



DESERT MATERIALS CORPORATION
Pumice crushing and screening plant and storage facilities at Sykes Siding, Inyo County. *Photo courtesy Whites Studios.*

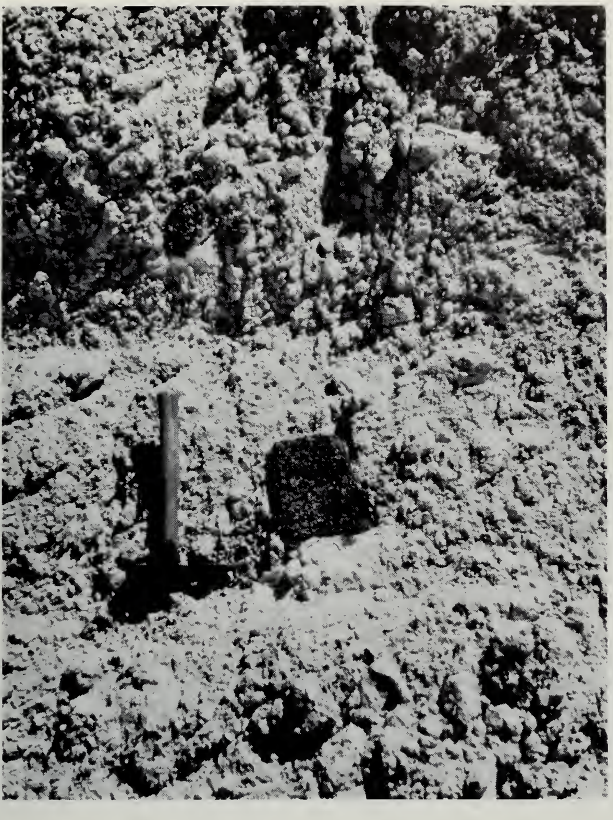


A. PUMICE BEDS

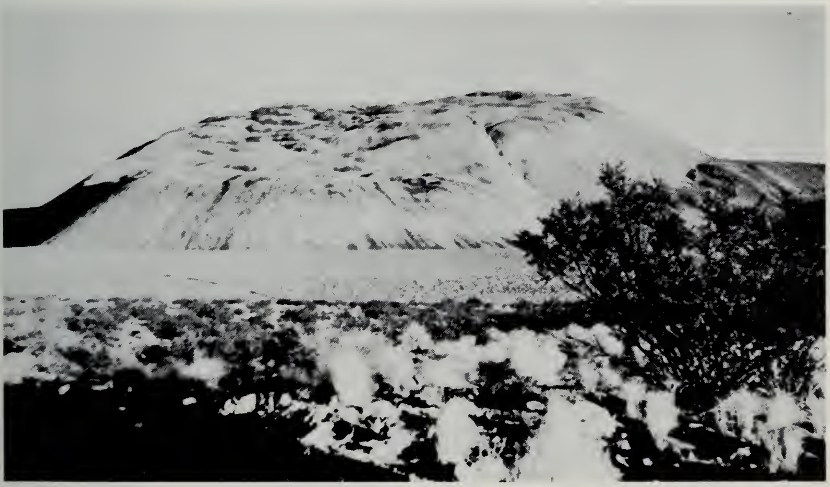
Exposed in one of the pits operated and owned by Desert Materials Corporation, southern Coso Range. Note dark soil layers separating successive beds of pumice. Also, lack of sorting as to size and lack of well-defined bedding. Length of pick handle is 12 inches. *Photo by C. W. Chesterman.*

B. INDEPENDENT MINE (CASHIER)

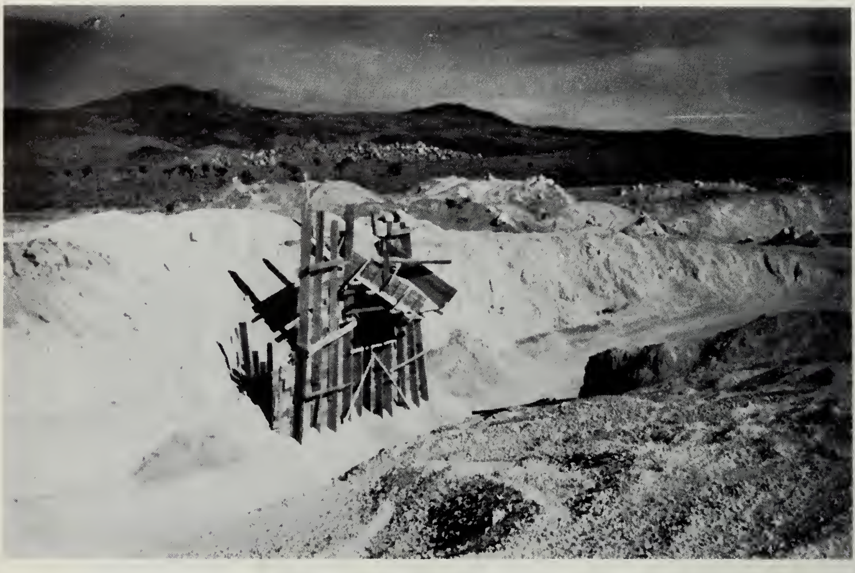
Panamint Range. Main adit shown at extreme right, old mill and shaft on left of hill.



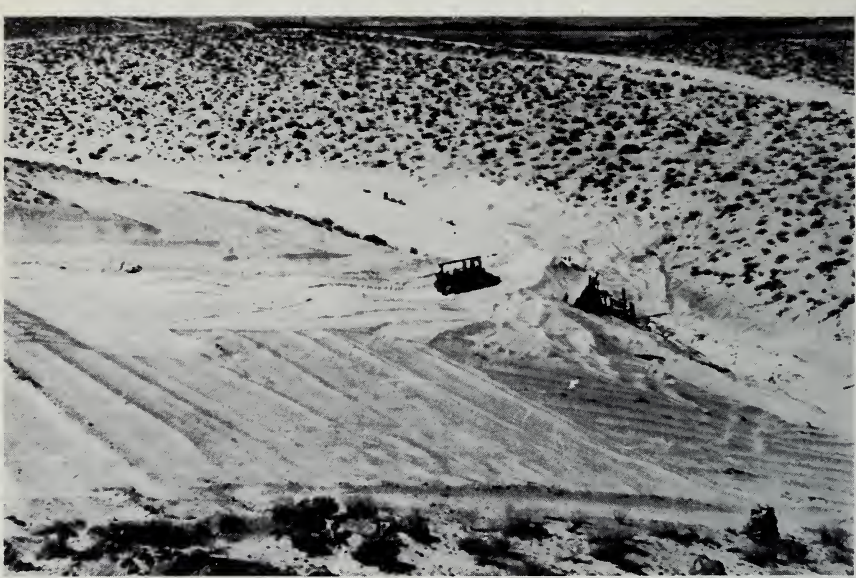
A. CLOSE-UP OF PUMICE
In same pit as mentioned in plate 24. Erratics are boulders of partly altered hornblende andesite.
Photo by C. W. Chesterman.



B. BLACK MOUNTAIN
Southern Coso Range. Mountain is volcanic plug made up almost wholly of pumiceous perlite. Note steep slopes and hummocky upper surface. *Photo by C. W. Chesterman.*



A. PUMICE PIT
Of Desert Materials Corporation, southern Coso Range.
Photo by C. W. Chesterman.



B. VAN LOON "FINES" PUMICE PIT
And screening plant. *Photo by C. W. Chesterman.*

Total production figures for these mines are not available, but during the two-year period, 1948-49, a total of 24,606 tons of milling-grade ore and 15,188 tons of shipping-grade ore was produced. Of the total shipping-grade ore, nearly 85 percent was produced during 1949.

Power for the mine and mill is obtained from four General Motors diesel generators producing at a total rate of 280 KVA. Diesel compressor capacity totals over 800 cubic feet per minute. Electric hoists are used at both shafts.

The camp and mill are at Noonday City south of the mines. There is a 10,000-foot power line from the generator at the Columbia No. 2 shaft to the mill and camp site.

The average crew is 45 men.

Silver Spoon Mine.[120] Location: On the west slope of the Argus Range about 1 airline mile southeast of Darwin in sec. 25, T. 19 S., R. 40 E., and sec. 30, T. 19 S., R. 41 E., M.D.M. Ownership: 5 claims are owned by Theodore Peterson, Darwin, California.

Workings consist of a 75-degree inclined shaft with levels at 150 and 250 feet. The 150-foot level has approximately 275 feet of drifts and crosscuts and the 250-foot level has 240 feet of workings.

The mine has been worked intermittently by lesseees and the owner. In 1940 L. H. Buckner had a lease for a few months on part of the mine and made one 20-ton shipment, part of which was concentrate from ore sent to the mill at Old Coso. In August 1946 the present lessee, B. Quinn, made a 60-ton shipment of ore assaying 16 percent lead, 12 percent zinc and 7 ounces of silver per ton. In December of 1947 the owner made a 49-ton shipment of ore. Quinn has made some other shipments, one of 50 tons, to the International Smelting and Refining Company at Tooele, Utah.

Two men are employed.

Surprise Mine. Location: On the eastern flank of the Argus Range, approximately in sec. 20, T. 19, S., R. 42 E., (projected). Ownership: A. L. Foss and the J. L. Osborne Estate, Panamint Springs, California, hold 3 unpatented claims, 2 of which are the Surprise and the Broken Ledge.

The ore minerals are principally galena, cerussite and anglesite, with some pyromorphite (lead chlorophosphate) in irregular replacement bodies in limestone. The limestone beds are contorted but locally trend east and dip about 50° south. The deposit is characterized by the irregularity of the shape and attitude of the orebodies. The tenor of the ore is high.

From a chimney-like orebody in a raise near the end of the 160-foot main adit, 210 tons of ore was mined. This orebody was stoped to within 10 feet of the surface in this raise; its lower extension was intersected by a 50-foot drift driven from a winze connecting with the main adit 110 feet from the portal, and was mined from this level by a 30-foot raise inclined 70 degrees and a 15-foot winze with an appended 50-foot drift. The winze from the main adit was sunk on another orebody. Another adit, 60-feet in length, has been driven 75 feet vertically below the main adit. Underground workings total 450 feet.

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[120] Tucker, W. B., and Sampson, R. J., op. cit., p. 455, 1938.
Kelley, V. C., op. cit., p. 561, 1938.

The property was located in 1941. One shipment of ore was made by Slater and Osborne in 1942. Subsequent shipments by Foss have brought the total production to 700 tons of ore which has assayed from 20 to 40 percent lead, 20 ounces of silver, and 0.07 ounce of gold per ton.

Ore is transported from the mine to a 48-ton loading bin by means of a 1300-foot aerial tram. Trucks haul the ore to Keeler, a distance of 55 miles, for rail shipment to the smelter.

One man is employed by Foss.

Ubehebe Mine. Location: 25 airline miles northeast of Keeler and 4 miles north of Ubehebe Peak in sec. 1, T. 14 S., R. 40 E., M.D.M. (projected). Ownership: 12 unpatented claims are owned by Ubehebe Lead Mines, Incorporated, 356 S. Spring Street, Los Angeles, California (Grant Snyder and C. A. Rankin). Under lease to Henry Hageman, Beatty, Nevada, and Louis Hines.

Irregular replacement orebodies of lead and zinc in limestone are cut by diorite dikes. Ore minerals include galena, sphalerite, lead carbonate, and lead sulphate.

The property has been worked by a series of adits and open cuts. In 1948 and 1949, the main adit was extended 100 feet by lessees. Ore shipped to smelters during the two years was 352 tons which assayed 20 percent lead, 13 percent zinc and 5 ounces of silver per ton.

Two men are working.

Ventura Mine (Silver Reef). Location: On the west slope of the Inyo Mountains in sec. 23, T. 16 S., R. 38 E., M.D.M. (projected) about 4½ airline miles northeast of Keeler. Ownership: Mrs. Ethel Thompson, Route 3, Box 1015, Yucaipa, California, owns 1 patented and 15 unpatented claims.

A quartz monzonite intrusion in limestone country rock has produced a garnet-rich tactite rock. Two well defined veins have formed in fissures in this tactite; one vein strikes N. 30° W. and dips 70° to 80° W. and the other strikes N. 20° E. and dips 80° E. These two intersect on the ridge north of the 150-foot main Ventura shaft. The ore occurs as irregular lenses of galena and cerussite in these veins.[121]

Workings include the Ventura shaft and seven crosscut adits. During 1949 the property was leased by the Sierra Ventura Mines, Incorporated, Oscar Vogt, president, 1850 W. Manchester, Los Angeles, California. The lowest adit, No. 7, was extended 100 feet in an effort to reach the intersection of the two veins below the shaft level. The total length of this adit is now 350 feet. Approximately 1500 feet of diamond drilling was done from the surface. Shipments of ore made before 1938 assayed 30 to 33 percent lead, 1 to 2 percent zinc, and 12 ounces of silver per ton; one 20-ton shipment in 1949 assayed 5.4 percent lead, 4.8 percent zinc, and 1.24 ounces of silver.

The total value of minerals produced by the mine, now idle, is reported to be $100,000.[122]

Zinc Hill Mine (Utacala Group, Colorado Group). Location: On the west slope of Zinc Hill in the Argus Range in sec. 35, T. 18 S., R. 41 E. or sec. 2, T. 19 S., R. 41 E., M.D.M. (projected) about 6 airline miles northeast of Darwin. Ownership: 5 unpatented lode claims are owned by the Combined Metals Reduction Company, Salt Lake City, Utah.

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[121] Tucker, W. B., and Sampson, R. J., op. cit., p. 458, 1938.
[122] Tucker, W. B., and Sampson, R. J., idem.

The ore, principally oxidized zinc minerals with some sphalerite and galena, occurs as replacement bodies in limestone bedding planes. Ore deposition was probably controlled by two sets of faults, one striking N. 35° E. and the other striking east.[123] The bedding planes strike approximately northwest and dip 35° NE. The orebodies are from a few feet to 25 feet thick, as much as 50 feet in strike length, and an unknown length down dip.

There has been little underground work done, although the outcrops have been mined close to the surface. The present owners operated intermittently in 1941, 1942, 1943 and 1946, and their total production has been about 2500 tons of zinc ore. Some of the oxidized ore was shipped to to the Pacific Zinc Company at Richmond, California, and some ore to the owners' plant in Bauer, Utah.

During 1918, the mine was one of the largest producers of zinc ore in Inyo County. During the periods January to April 1947 and January to May 1949, the property was leased by Royal J. Wright and Tom Taylor who shipped about 25 tons of lead ore, assaying 35 percent lead and 12 to 15 ounces of silver per ton, to the International Smelting and Refining Company at Tooele, Utah. Some sphalerite was shipped to the Bauer, Utah plant of Combined Metals Reduction Company. The ore was produced from a 55-foot drift. Production of ore from the mine prior to that of the present owners is not recorded.

The property is idle.

Manganese

Manganese in Inyo County is in bedded wad deposits (impure mixtures of manganese and other oxides); fissure deposits, in which manganese oxide is found in and adjacent to fissures especially fissures in volcanic rock, conglomerate and sandstone; and as a concentration in gossan zones in metamorphosed rock. Most of the deposits are in the Wingate Wash district in the south-central part of the county; others are in the Slate Range, in the northern part of the Coso Mountains, and in the Inyo Mountains. Location, extent, and tenor of the orebodies have not been conducive to their exploitation. A small tonnage of ore was shipped from a single property in Wingate Wash in 1943.

Manganite Group. Location: Wingate Wash in the southern end of Death Valley in secs. 28 and 33, T. 21 N., R. 2 E., S.B.M. Ownership: 6 unpatented claims, Reward Nos. 1, 2 and 3, Good Hope Nos. 1 and 2, and Reward are owned by Arthur R. Cassidy, 220 E. 19th Street, Bakersfield, California, Catherine E. and Sarah Williams.

The deposits consist of bog-type manganese ore in tilted and faulted Pleistocene lake bed sediments, in which pyrolusite, psilomelane, and rhodochrosite are interbedded with shale over an area of about 46 acres. The ore is concentrated near fissures. Reserves are estimated at more than 40,000 tons of ore containing an average of 8 percent manganese per ton; assays show the manganese content to range from 6.18 to 11.1 percent. A few surface cuts comprise the development work.

The property is idle.

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[123] Johnson, S. W., Combined Metals Reduction Co., personal communication.

Wingate Wash Manganese Deposit (Black Dream). Location: 7.1 miles west of the west-side road of Death Valley alongside Wingate Wash road in T. 20 N. (?), R. 1 or 2 E., S.B.M. (projected) or about 32 airline miles west of Shoshone. Ownership: 11 unpatented claims are owned by Roy C. Troeger, 4600 Encino Avenue, Encino, California.

Manganese ore of the Wingate Wash is in fissure deposits in Tertiary conglomerate and sandstone.[124] The principal deposits are on a ridge where the fissures strike N. 20° to 50° W., dip 45° to 60° W., vary from 2 to 8 feet in thickness, and may be as much as 50 feet in length. The deposit has been exploited by a series of open cuts from which 40 tons of ore was shipped by lessees, according to the owner. Other manganese ore outcrops are on the property. An analysis of ore shipped is not available, but the average grade of ore is estimated at 25 percent manganese.[125]

The property is idle.

Molybdenum

Most deposits containing molybdenite, chemically molybdenum sulphide and economically the chief ore mineral of molybdenum, are genetically related to acidic igneous rocks. Many of the contact-metamorphic deposits, such as those worked for tungsten, also contain recoverable amounts of molybdenite.

The principal source in Inyo County, and in California, is the Pine Creek mine, a contact-metamorphic tungsten deposit, where molybdenite is associated with scheelite in all of the five known orebodies. The average grade of the ore milled has been from 0.40 to 0.45 percent MoS_2.

Wulfenite, lead molybdate, although of little commercial importance, is a common mineral in the oxidized zones of galena-bearing deposits, such as those of the Ophir mine in the Slate Range district, the Cerro Gordo mine, and mines in the Darwin district.

Quicksilver

The Coso Hot Springs area in the Coso Mountains has been the only source of the small production of quicksilver recorded from Inyo County. Two hundred thirty-one flasks were shipped from the district during the period 1931-1940, following the discovery of mercury minerals in the solfataric altered zones during the early 1920's.

The area consists of interbedded volcanic rocks, including rhyolitic ash, tuff, and flows, which overlie granitic intrusives; all have been altered by intense thermal action. Cinnabar and metacinnabar, associated with crystalline sulphur, are deposited throughout the siliceous sinter and altered rocks. Vapors escaping from the springs and vents carry appreciable amounts of quicksilver. The district is within the boundaries of the U. S. Naval Ordnance Test Station, Inyokern.

Cinnabar and metacinnabar have been reported from other deposits in the county. Both minerals, according to Waring and Huguenin,[126] are in a vein in limestone at the Chloride Cliff mine in the Funeral Mountains. Metacinnabar is an associated mineral with stibnite and its alteration products in the Rocket antimony claim in the Argus Range.[127]

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[124] Trask, Parker D., Geologic description of the manganese deposits of California: California Div. Mines Bull. 152, p. 81, 1950.

[125] Trask, Parker D., op. cit., p. 81.

[126] Waring, Clarence, and Huguenin, Emile, op. cit., p. 121, 1919.

[127] See under tabulated list of mines herein.

Coso Quicksilver Deposit. Location: 18 airline miles N. 10° E. of Brown in the Coso Mountains; secs. 5-8, T. 22 S., R. 39 E., M.D.M. Ownership: Within U. S. Naval Ordnance Test Station, Inyokern, California.

Mercury minerals were discovered in the Coso Hot Springs area in the early 1920's.[128] The deposits have been fully described by several authors.[129]

Most of the mercury is in the form of cinnabar, with minor amounts of metacinnabar. The minerals are small seams, grains, and coatings in irregularly shaped bodies of random distribution associated with the sinter vents of the hot springs. Country rock consists of granite, rhyolite, volcanic tuff, and other bedded volcanic rocks; all are altered by solfataric action.

Principal exploration work has been in the Devil's Kitchen area and consists of numerous trenches 8 feet deep, 6 feet wide and 200 to 400 feet long, and shallow shafts 10 to 40 feet deep. Total production of the property as reported by Dupuy [130] was 220 flasks of quicksilver. Ross and Yates [131] report a total production of 231 flasks of quicksilver from the Coso district between 1931 and 1940.

In 1948, the U. S. Bureau of Mines sampled the area extensively by rotary-bucket drilling, hand auger and channel cuts.[132] About 1160 samples were assayed. No estimated tonnage of average grade ore is given, but the grade appears to be less than the 8 to 10 pounds of recovered-quicksilver-per-ton reported by Tucker and Sampson.[133] The average grade of all material classed as ore is stated by Ross and Yates [134] as being less than 2 pounds of mercury per ton.

Tungsten

Production of tungsten in Inyo County has come principally from the Bishop area. The deposits in this area are distributed along the eastern slope of the Sierra Nevada and in the Tungsten Hills. The district, extending from Round Valley southward about 20 miles, includes the Pine Creek area to the west. It is one of the few areas in the world where scheelite occurs in commercial quantities in contact-metamorphic deposits.

Tungsten production from this district through 1948 has been about 900,000 units of WO_3, of which about 85 percent has come from the Pine Creek area. The estimated total production through 1945 from the Tungsten Hills was 125,000 units of WO_3.[135] The largest percentage of the ore produced at Tungsten Hills was mined during the period 1916-18. Most of the Pine Creek ore has been produced since 1938.

A second, and much less important, tungsten-producing area is the Darwin district. Tungsten minerals have been known from here since before World War I, but no tungsten ore was mined until 1941. Small amounts of tungsten have been produced from the Deep Springs Valley area and the Ubehebe district.

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[128] Fraser, H. J., and others, Hot springs deposits of the Coso Mountains: California Div. Mines Rept. 38, p. 223, 1942.

[129] See tabulated list of mines and mineral deposits.

[130] Dupuy, Leon W., Bucket-drilling the Coso mercury deposit, Inyo County, Calif.: U. S. Bur. Mines Rept. Inv. 4201, p. 3, March 1948.

[131] Ross, Clyde P., and Yates, Robert G., The Coso quicksilver district, Inyo County, California: U. S. Geol. Survey Bull. 936q, p. 397, 1943.

[132] Dupuy, Leon W., idem.

[133] Tucker, W. B., and Sampson, R. J., op. cit., pp. 460-462, 1938.

[134] Ross, Clyde P., and Yates, Robert G., op. cit., p. 407.

[135] Bateman, Paul C., Erickson, Max P., and Proctor, Paul D., Geology and tungsten deposits of the Tungsten Hills, Inyo County, California: California Jour. Mines and Geol., vol. 46, p. 23, 1950.

The reader is referred to recently published information on the Tungsten Hills [136] for a description of mines in that area.

Adamson Mine.[137] Location: On the north branch of Morgan Creek about one mile southeast of Mt. Morgan in secs. 29, 30, T. 6 S., R. 30 E., M.D.M. (projected) at an altitude of 11,500 to 12,800 feet. Ownership: 8 unpatented claims are owned by D. B. Adamson, Bishop, California.

This mine adjoins the Pine Creek Mine on the north and is on the same geologic structure, the Pine Creek pendant. Two orebodies, the Northwest orebody and the Ridge orebody, have been prospected and mined. The Northwest orebody is a horseshoe-shaped tactite zone extending around and over a block of marble and hornfels that is split off from the main pendant. The Ridge orebody, 2000 feet to the east and about 1300 feet higher, is a tactite bed several hundred feet long, from 15 to 20 feet thick, and is surrounded by hornfels. Directly north of the Pine Creek mine are continuations of the metamorphic rocks with a few thin scheelite-bearing tactite bands. These have been explored by the 1300-main adit for about 400 feet, but no ore was mined.

In the Northwest orebody, all the ore above the 1300-foot north adit was mined. There are about 1600 feet of level workings from this adit. Samples from this orebody show an average of 0.59 percent WO_3. The Ridge orebody was worked only by means of open cuts. Samples taken along a 120-foot length show an average of 1.10 percent WO_3. A tramway connects the workings in this orebody with a bin near the Northwest workings.

In 1941 the property was leased to W. B. Lenhart and C. F. Johnson. During 1942 and 1943 the property was operated under lease by Panaminas, Incorporated, 230 Park Avenue, New York. These operations were discontinued in 1944 after producing 38,609 tons of ore which was milled in the Pine Creek mill with a recovery of 18,109 units of WO_3.

Bakoch Group. Location: On the east slope of the Sierra Nevada on a ridge between Big Pine and Baker Creeks, approximately in sec. 27, T. 9 S., R. 33 E., M.D.M. (projected) about 4½ airline miles southwesterly from Big Pine. Ownership: Nick Bakock and John Somerville, Big Pine, California, own 5 unpatented claims (1944).

Very fine-grained scheelite is disseminated in tactite along a contact between limestone and granodiorite. The contact zone strikes northwest and dips 50° SW. The lens of tactite next to the limestone footwall has a maximum width of 30 feet and crops out for 300 feet.

An adit has been driven along the contact for 110 feet; 90 feet from the portal a raise was driven along the footwall 95 feet to the surface. Here a glory hole was started from which 300 tons of ore was mined.

Ore hauled to the mill, two miles southwest of Big Pine on Big Pine Creek, was crushed in an 8- by 15-inch jaw crusher and elevated to a pair of 125-ton bins. From these bins, the ore was further crushed by two 12- by 20-inch rolls, and after screening, was passed through hydraulic cone classifiers to provide sized feed for each of four Economy concentrating tables. Equipment was motor driven through line shafting. Electric power was supplied by the City of Los Angeles. Mill capacity was 50 tons per day.

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[136] Bateman, Paul C., Erickson, Max P., and Proctor, Paul D., op. cit.

[137] Bateman, Paul C., Pine Creek and Adamson tungsten mines, Inyo County, California: California Jour. Mines and Geol., vol. 41, pp. 231-249, 1945.

The mine and mill were last operated in 1944 by the Twin Pines Mining and Milling Company, I. D. Ewart and A. D. Gard, Los Angeles. This company is no longer in existence and the property is idle.

Bishop Concentrate and Cleaning Company (Bishop Tungsten Mines Mill, Rossi Mill). Location: About half a mile west of Highway 395, 6 miles south of Bishop, approximately in NE¼ sec. 7, T. 8 S., R. 33 E., M.D.M. Ownership: The mill is owned by G. E. Benware, Bishop, California.

The Old Bishop Tungsten mines mill has been converted to a custom cleaning plant for scheelite concentrate. It is also equipped for custom milling of tungsten ore.

In the cleaning section, the concentrate is elevated from a hopper and discharged into a 10-inch automatic roaster, fired by butane and equipped with Wheelco instrument control. The roaster product is cooled and elevated to a 155,000-ampere Dings electrostatic separator with an 18-inch belt. The capacity of this unit is ½ ton per hour. Recent additions to the mill include a Stearnes electrostatic separator which operates ahead of the roaster, removing considerable material prior to roasting.

In the milling section, crude ore can be stored in a 45-ton bin from which it is fed to a jaw crusher and into a 65-ton fine-ore bin. A 50-ton Straub ball mill is in closed circuit with a 10-mesh screen, with minus 10-mesh material fed to five concentrating tables. A 15-ton Straub mill is available for very small lots of ore or for regrinding small lots of concentrate.

Division Creek Tungsten Mine.[138] Location: On the east slope of the Sierra Nevada between Division Creek and Goodale Creek in sec. 35, T. 11 S., R. 33 E., M.D.M. (projected). Ownership: 6 claims are owned by J. L. McCullough, Independence, California; L. L. McAfee, T. W. Key, Roy Adamson, Bishop, California; and H. N. Shepard, Los Angeles, California.

Scheelite is disseminated through a garnet-rich tactite zone, which strikes N. 30° E. and dips 45° to 60° E., along a contact of dolomite with granite. Work done by the Cardinal Gold Mining Company of Bishop in 1939 consisted of shallow open cuts and a 25-foot adit driven N. 20° E. A grade of 1.75 percent WO_3 was reported for 15 tons of ore milled at the El Diablo mill near Bishop.

In 1941 the Nevada-Massachusetts Company leased the property and completed a two-mile road from Scotty's Spring on Division Creek to the mine. A 25-foot shaft was sunk, 15 tons of ore mined and shipped to Nevada.

The property is idle.

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[138] Tucker, W. B., and Sampson, R. J., op. cit., pp. 568-569, 1941.

Hanging Valley Mine (J and M Group, Millovich prospect). Location: In approximate center of W½ sec. 22, T. 7 S., R. 30 E., M.D.M. (projected) at an altitude of 11,500-12,000 feet, about one mile southwest of the Tungstar Mine. Ownership: 12 unpatented lode claims and 5 millsites are owned by Juno Millovich, Bishop, California and Fred R. Lee and J. W. Wilhoit of San Diego, California. Leased to Hanging Valley Mining Corporation, Gayle Green, president, 1545 W. 87th Street, Los Angeles 47, California.

A scheelite-bearing tactite zone in marble strikes N. 55° to 60° W. and has a nearly vertical dip. The tactite is garnetized and contains quartz and some large epidote crystals. Most of the scheelite crystals are visible.

The property was originally worked by a 15-foot vertical shaft into the outcrop of the tactite. An adit which intersected this shaft at the bottom was driven westward 380 feet. Two crosscuts branch off the adit to the southwest and turn westward. A 40-foot inclined winze has been sunk 70 feet from the start of the second crosscut, and some diamond drilling has been done from the bottom of the winze. All stoping has been above the adit level.

The ore was hauled in a 10-ton trailer by a tractor over a two-mile road to a 50-ton transfer bin at Horton Lake. Trucks then hauled the ore 14 miles to the Red Hill Mill near Bishop Creek about four miles west of Bishop. Ore was fed from an 80-ton crude-ore bin into a 10- by 20-inch jaw crusher and discharged to a crushed-ore bin. Two 3- by 4-foot Straub ball mills reduced the ore to minus 16-mesh material which was fed onto concentrating tables. The concentrate was treated by flotation to remove pyrite and after drying, was cleaned in a magnetic separator. Mill capacity was about 60 tons per day.

Total production for the operating years of 1947 and 1948 was about 3000 tons.[139] The average grade based on mill recovery was 1.25 percent WO_3. There was no activity during 1949 and the property is idle. The Red Hill Mill has been turned back to the owners, the R. E. Campbell Estate, Bishop, California.

Huntley Industrial Minerals, Incorporated. Location: In the Deep Creek area of the Tungsten Hills west of Bishop in sec. 13, T. 7 S., R. 31 E., M.D.M. Ownership: Huntley Industrial Minerals, Incorporated, W. H. Huntley, president, Bishop, California owns several of the Tungsten City group of claims.

In 1937 a mill was built by the Tungsten City Milling Company to treat the tailings from the Tungsten Mines Company operations (Little Sister, Jack Rabbit and Lookout mines) and the tailings from the Standard Tungsten Company mill (Aeroplane mine).[140] The concentrate produced averaged 72 percent WO_3. Tungsten production from this operation was reported for the period 1937-39.

During 1944 and 1945, Huntley Industrial Minerals, Incorporated, reworked some of the tailings for the garnet content. The garnet was recovered by gravity concentration using one Deister and three Straub-Overstrom concentrating tables. The heads averaged 56 percent garnet, and the finished, dried product was relatively pure. Huntley[141] reports that an estimated 200,000 tons of tailings, averaging 56 percent garnet and 0.4 percent WO_3, will be treated.

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[139] Green, Gayle, personal communication, 1950.
[140] Tucker, W. B., and Sampson, R. J., op. cit., p. 467, 1938.
[141] Huntley, W. H., personal communication, 1950.

Jumbo Mine.[142] Location: On the west slope of the Inyo Range 4 miles east of Kearsarge in the E½ sec. 15, T. 13 S., R. 36 E., M.D.M. (projected) at an altitude of 7000 to 7500 feet. Ownership: J. W. Thompson, Independence, California and G. E. Lund, Jr., Los Angeles, California own 6 unpatented claims.

The scheelite is typically disseminated in tactite along a contact between granite and lime and shale. The tungsten content of the lenses of tactite along the contact ranges from 1.40 to 2.49 percent WO_3.

Iron oxides and copper carbonates, carrying gold and silver, are in a quartz vein which trends northeast and dips 75° SE. along the contact. The vein ranges from 1 foot to 3 feet wide.

A 120-foot adit has been driven southwest along the contact, which has also been intersected by a 60-foot crosscut adit. An inclined shaft has also been sunk on the contact to a depth of 240 feet.

There has been no production and the property is idle.

Lakeview Tungsten Mine.[143] Location: In the NW¼ sec. 21, T. 7 S., R. 30 E., (projected) on the east side of a small lake on the west fork of Gable Creek at an altitude of 10,700 to 11,000 feet, about 2½ airline miles due south of the junction of Gable Creek and Pine Creek. Access to the property is by a 4-mile trail up Gable Creek from the Tungstar Mill. Ownership: George Brown, of Bishop, California, owns three-quarters interest and Kenneth Irons, also of Bishop, owns one-quarter interest in 7 unpatented mining claims.

The deposit is a tactite mass 50 feet wide and 125 feet long that strikes N. 10° W. and dips 80° W. to vertically. It lies between granite on the east and marble on the west. The ore zone within the tactite averages 12 feet in width and consists of coarse scheelite crystals in a coarsely crystalline epidote-garnet-quartz gangue.

A 15-foot shaft and an open cut 20 feet long, 12 feet wide, and 8 feet deep on the outcrop and a 20-foot adit, 100 feet below the outcrop comprise the workings. Assays have shown from 1 to 5 percent WO_3. Total production has been less than 100 tons of ore, of which 59 tons averaging 5 percent WO_3 was milled at the Western Tungsten mill, and 30 tons averaging 2½ percent WO_3 was milled at the Tungstar mill.

The property is idle.

Lambert Tungsten Mine. Location: In sec. 11, T. 7 S., R. 30 E., M.D.M. (projected), near the head of Huckleberry Canyon at an altitude of 10,500 to 11,000 feet. Ownership: 7 unpatented mining claims are owned by Stanley Lambert (address unknown).

Scheelite in a garnet-epidote tactite rock is in the contact zone of granodiorite with limestone. The ore shoot which has been mined is 90 feet long and from 6 to 8 feet wide.

One adit, 90 feet below the bottom of an open cut, is 119 feet long, and another adit is 55 feet long. These two adits are the chief workings, although there are several smaller open cuts.

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[142] Tucker, W. B., and Sampson, R. J., op. cit., p. 569, 1941.

[143] Lemmon, Dwight M., Tungsten deposits in the Sierra Nevada near Bishop, California: U. S. Geol. Survey Bull. 931e, p. 95, 1941.

The property was leased in 1941 by K. G. Irons, Bishop, California, and was operated in 1942 and from May to November 1943. The 1942 production totaled 28½ tons of ore which assayed 6 percent WO_3. The 1943 production through August was 115 tons of ore. All ore was packed out by mule over a 3-mile pack trail and a 6-mile road to the Tungstar mill on Pine Creek. Fifteen men, including four packers, were employed.

The property is idle.

Little Shot (Brooks Mine). Location: At the north end of the Tungsten Hills about 1500 feet east of the Round Valley Mine in SW¼ sec. 35, T. 6 S., R. 31 E., M.D.M. Ownership: 4 unpatented mining claims are owned by G. Crawford and associates, Bishop, California.

Scheelite is disseminated through stratified tactite beds which strike N. 45° E. and dip 50° to 75° SE. The tactite is bounded on the west by quartzite and on the north and northeast by granite.

The deposit has been worked by an adit driven S. 45° and a 65-degree inclined shaft which connects with the adit and goes about 30 feet below the adit level. There is an 18-foot drift at the bottom of the shaft and about 200 feet of workings on the adit level. There are also several prospect pits.

The property was leased from June to December 1948 by C. H. Brooks and associates, 1505 W. 5th Street, Santa Ana, California. About 180 tons of ore was shipped to the Red Hill mill, west of Bishop. The grade of ore based upon mill recovery was about 0.50 percent WO_3. Two 50-foot diamond drill holes were bored.

The property is idle.

Little Sister Mine.[144] Location: In the Tungsten Hills about 7½ airline miles west of Bishop in secs. 12, 13, T. 7 S., R. 31 E., M.D.M. Ownership: The Little Sister claim is owned by the El Diablo Mining Company, Bishop, California (1942).

The Little Sister mine has been the largest producer of tungsten in the Tungsten Hills. The scheelite is in the tactite part of a block of metamorphic rocks enclosed in quartz diorite. The metamorphic block includes light-colored calc-silicate rock and coarsely crystalline white marble in addition to the tactite.

The property has been worked by means of a large glory hole and a smaller glory hole, both connected to a haulage adit by numerous raises and stopes.

The total production is estimated at 150,000 tons of ore containing 0.5 percent WO_3, most of which was mined by the Tungsten Mines Company during the period 1916-1918. From 1937 to 1940, the El Diablo Mining Company produced 14,372 units of WO_3 from 24,175 tons of ore. The Bishop Tungsten Company produced 2900 tons of ore during a brief period in 1941.

The property is idle.

Marble Mine (Shannon Creek Mine, Shannon Creek Tungsten Deposit). Location: In Shannon Canyon on the east slope of the Sierra Nevada about 10½ miles south of Bishop in sec. 31, T. 8 S., R. 33 E., M.D.M. at an altitude of 5700 feet. Ownership: A. H. Peterson and John Utter estate, Bishop, California. Number of claims is unknown.

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[144] Bateman, Paul C., Erickson, Max P., and Proctor, Paul D., op. cit., pp. 34-35, 1950.

Fine-grained scheelite is evenly disseminated through a northwest trending, vertically dipping, garnetized tactite zone on the contact between granite and crystalline limestone.

The zone has been worked for a length of 150 feet, a depth of 170 feet, and widths ranging from 5 to 20 feet. Openings consist of several adits totaling 200 feet in length, a 65-foot incline with a 35-foot vertical winze, a 50-foot shaft inclined at 80 degrees, and several raises.

The property was leased in 1941 to Robert W. Kelso of Bishop, California. During 1941, 200 to 300 tons of ore was milled in the El Diablo mill. In 1942, a 30-ton mill was constructed, and through August 1943, 3200 tons of ore averaging 0.40 percent WO_3 was treated. Estimates of ore reserves range from 10,000 tons assaying 0.40 percent WO_3 to 18,000 tons assaying 0.50 percent WO_3. The property was operated in 1944, but no production figures are available.

The property is idle.

Pine Creek Mine. Location: About 20 airline miles west of Bishop on a branch of Morgan Creek, which is tributary to Pine Creek from the north, in secs. 30 and 31, T. 6 S., R. 30 E., M.D.M. (projected) at an altitude of 11,000 feet. Ownership: United States Vanadium Corporation, 30 E. 42nd Street, New York 17, New York, W. J. Priestley, president, owns 5 patented and 7 unpatented mining claims in sec. 31, T. 6 S., R. 30 E., 360 acres in sec. 30, T. 6 S., R. 30 E., and 263.14 acres in secs. 19 and 20, T. 6 S., R. 31 E., M.D.M.

The Pine Creek deposit was discovered in 1916 and operated from 1917 to 1919 by the Pine Creek Tungsten Company. The Tungsten Products Company operated the property from 1922 to 1926. The United States Vanadium Corporation has owned the property since 1936.

The geology of this contact metamorphic deposit has been described in detail by Bateman.[145] The Pine Creek mine contains the largest known reserve of tungsten ore in the United States, and in addition produces molybdenum, copper, silver and gold. The orebodies are near the north end and on the west side of the Pine Creek pendant, an elongate block of metamorphic rocks surrounded by intrusive granite and quartz diorite. The pendant, 5½ miles long and 1 mile wide, is composed of hornfels, schist and quartzite, with some marble in a 3½ mile area on the west side. All of the orebodies are in the north-trending zone of contact between this marble and granite.

The contact zone consists of garnet-diopside tactite, and quartz and quartz-feldspar rocks. The tungsten orebodies are restricted to the tactite; except for small amounts recovered from powellite, tungsten is obtained only from the mineral scheelite, which in many places also contains molybdenum. Associated with the scheelite are epidote, wollastonite, calcite, and fluorspar, as well as the molybdenum ore minerals, molybdenite and powellite, and the primary copper sulphides, chalcopyrite and bornite.

The tungsten ore shoots are persistent, especially in their vertical dimension, and are sufficiently large to be mined individually. The molybdenum ore shoots are smaller and not as continuous as the tungsten shoots, and the two are only partly co-extensive. Five orebodies have been developed and mined in the upper workings. These are, from north to south, the Loop, Level E, Pinnacle, North, and South orebodies.

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[145] Bateman, Paul C., op. cit., pp. 231-249, 1945.

The Pine Creek mine has four main levels at the upper workings and a new Zero level, about 1500 feet below these, from which future production is planned. At the upper workings, the main haulage way is the A-level, at an altitude of 10,790 feet.[146] This level consists of a 2000-foot crosscut adit, driven N. 32° E., from which drifts have been driven both north and south. Above the level are five sub-levels, A-1, A-2, A-3, A-4, and A-5, up to C-level which is at an altitude of 11,070 feet. Drifts on C-level extend as far north as the Level E orebody. There are two sub-levels, C-4 and C-7, above C-level. The North and South orebodies were mined from both A and C levels. Also from the A-level, a 250-foot winze was sunk on the North orebody to the 250-level. The Pinnacle orebody was mined by open cut and was explored below by C-7 sub-level, but no ore was found. The Level E orebody was mined by open cut and by stopes from E-level at an altitude of 11,370 feet. The total length of underground workings in these levels is more than four miles.

When the mine was first opened by the United States Vanadium Company, shrinkage stoping was the mining method used. During the period of World War II, the shrinkage stope method was abandoned in favor of a diamond drill blast hole method, in order to increase production. By 1946 the ore remaining on and above A-level was in the surface pits and in the walls of the blast hole stopes.[147] Since then production has been maintained by open pit work and from scavenging operations in the blast-hole stopes by side slabbing, using long diamond drill blast holes.

The long exploration adit, known as the Zero Tunnel, or 1500 level, was started in 1943 and completed in December 1947, when a short crosscut struck ore directly beneath one of the largest stopes on A-level. This adit is 1265 feet vertically below the 250-foot level and was driven N. 7° W. for a length of 7400 feet. The portal of this adit is 6000 feet south of the South orebody. After completion, the adit had to be widened to a 12-foot width to take care of the 5000-gallon-per-minute flow of water encountered and to allow for a track gauge of 36 inches.

Two orebodies will be mined above this level to the 1300 level by sub-level stoping methods. One block will have a 30-foot sub-level interval. The other will have a 75-foot interval. A comparison of the cost of extended-steel drilling in the 30-foot sub-levels and the cost of diamond drilling in the 75-foot block will determine the mining method to be used above the 1300 level.

A three-section aerial tram, two miles long, was constructed during 1940 and 1941 for ore haulage from A-level to the mill, which is at an altitude of 7700 feet. The capacity of the tram, using 1¼-ton buckets, was 1000 tons per 8 hours. The upper terminal of the first section from the mill is the portal of the Zero Tunnel. In February 1949, a fire destroyed the terminal and crusher installation at A-level, so all ore from there was hauled by truck to the Zero level installations during the balance of the year 1949. There is a seven-mile road from the mill past the Zero level portal to the upper workings.

The main transport on the Zero level is by a General Electric trolley locomotive hauling 12-ton rotary-dump cars. Storage battery locomotives are used in the headings. The 12-ton cars are dumped by a Differential Car Company rotary tipple into a 150-ton coarse-ore bin from which the ore is fed to a Traylor 36- by 48-inch jaw crusher. Crushed ore, averaging three to five inches, is discharged into a 1000-ton live storage bin from which it is fed into the aerial tram buckets by three 30-inch Link-Belt apron feeders.

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[146] Bateman, Paul C., op. cit., p. 233, 1945.

[147] Baker, David D., Pine Creek tungsten mine: paper presented at Am. Inst. Min. Met. Eng., Los Angeles Fall Meeting, p. 4, Oct. 20, 1949.

At the mill, tram buckets dump into a 300-ton crude-ore bin from which the ore is fed to a $5\frac{1}{2}$-foot Symons short head crusher, crushing to $\frac{1}{2}$ or $\frac{5}{8}$ inch. The crushed ore is stored in four steel bins, each with a live load capacity of 1000 tons. Some $\frac{5}{8}$-inch ore is stockpiled for winter use and for use in case of mine or tram shutdown. The mill is a combined flotation and chemical plant with a capacity of 1200 tons per day.

There are four identical grinding sections in the mill, each of which has a No. 65 Marcy open-end ball mill in closed circuit with a 54-inch Aikens classifier. Ninety-eight percent of the material ground in the ball mills will pass through a 65-mesh screen.[148] Four flotation sections produce a bulk sulphide concentrate. The molybdenum and copper sulphides in the bulk concentrate are further separated by flotation units in which the copper sulphides are depressed. Silver and gold are present in this copper concentrate.

The tailings from the bulk sulphide-float section are sent to two sections in which a scheelite concentrate is produced. This flotation concentrate, which contains calcite and fluorite in addition to the scheelite, assays no higher than 15 percent WO_3,[149] and is tabled to produce a high grade scheelite concentrate. The table tailings are sent to the chemical section of the plant for treatment embodying dissolution of the tungsten minerals in high temperature autoclaves followed by reprecipitation of the tungsten as artificial scheelite. Molybdenum, also dissolved, is reprecipitated as a molybdenum sulphate and roasted to molybdenum oxide.

If specifications require a very low molybdenum content in the tungsten concentrate, all of the tungsten flotation product is put through the chemical process instead of only the low-grade table tailings.[150]

Mill heads average from 0.4 to 0.45 percent WO_3, 0.4 percent MoS_2 and 0.25 percent Cu. The copper concentrate carries from 40 to 45 ounces of silver per ton and some gold. Total production through 1944 was 586,843 units of WO_3 and 2,655,281 pounds of molybdenum.[151] Very little was produced during 1945 and 1946 but production increased in 1947.

Compressed air at the upper workings is supplied by a Chicago-Pneumatic 2000 cubic-foot-per-minute compressor direct driven by a 400-horsepower electric motor and two Ingersoll-Rand compressors with a total capacity of 1650 cubic feet per minute. Zero-level requirements are furnished by one 3000 cubic-foot-per-minute Ingersoll-Rand compressor and two Ingersoll-Rand and two Chicago-Pneumatic compressors with a total capacity of 2000 cubic feet per minute. Ingersoll-Rand and Sullivan 50-horsepower double-drum slusher hoists are used in the stopes. Eimco model 21 mucking machines are used in the headings. A Chicago-Pneumatic 5 diamond drill with EX bits is used for blast holes and exploration work, and a Longyear Junior M with AX bits is used for exploration work. Electric power is purchased from the California-Nevada Power Company.

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[148] Tucker, W. B., and Sampson, R. J., op. cit., pp. 572-574, 1941.
[149] Baker, David D., op. cit., p. 2.
[150] Baker, David D., op. cit., p. 2.
[151] Bateman, Paul C., op. cit., p. 243, 1945.

H. L. McKinley is the plant manager, T. W. Holmes is mine superintendent, and L. E. Sausa is mill superintendent. The total number of men employed at mine and mill is 225.

Round Valley Mine (Big Shot, Noble, Noble's Camp). Location: SE¼ S. 34, T. 6 S., R. 31 E., M.D.M., about 9 airline miles west of Bishop; altitude between 5000 and 5100 feet. Ownership: 7 lode claims, Big Shot, and Big Shot No. 1 through No. 6, and Big Shot Placer No. 1 are owned one-third by W. A. Trout, H. O. Johanson, et al., and two-thirds by Al Stevens and Howard Stevens, all of Bishop, California. Leased since 1947 to the Otis A. Kittle Mining and Exploration Company, 2003 Arlington Avenue, Reno, Nevada and P. O. Box 478, Bishop, California.

This deposit lies at the north edge of the Tungsten Hills along the north side of the Round Valley pendant. The pendant is made up of marble and of tactite and calc-silicate rocks derived from the marble. The tactite and silicated rocks parallel the bedding which trends north and which dips west intersecting the granite contact at nearly right angles. The principal scheelite zones are parallel to the bedding and the scheelite content decreases away from the contact.

Several ore zones have been mined and the old mine workings consist of a large glory hole, several prospect pits and small glory holes, two adit levels, a 78-foot inclined shaft and a level from the bottom of the shaft driven in a westerly direction. Numerous raises and small gopher-hole-type stopes lie between the inclined shaft level and the large glory hole.

Most of the production from this property was made during the period 1917-18. The estimated total production through 1945 is 19,000 units of WO_3.[152]

The Kittle Company drilled 15 diamond drill holes (a total of approximately 1100 feet) at the west end of the property. A 150-foot winze was then sunk from the west end of the inclined-shaft level in a direction S. 75° to 90° W. on a 30-degree incline, and an adit to be used as a haulage way was driven to intersect the level. One large section of ore was stoped out to the surface on the north side of the winze; a pillar was left between this stope and the winze. Some ore still remains in the pillar and on the south side of the winze.

Total production by the Kittle Company since December 1947 has been 5500 tons of ore which showed an approximate average grade of 0.7 percent WO_3 on the basis of mill recovery. Ore is hauled to the El Diablo mill which the Kittle Company has leased. The mill is about three miles west of Bishop near Bishop Creek in sec. 10, T. 7 S., R. 32 E., M.D.M., and is owned by the El Diablo Mining Company, H. O. Johanson, manager, Bishop, California.

Ore from the 60-ton primary ore bin passes through an 18- by 24-inch Pacific jaw crusher to a crushed-ore bin. Material is then fed to a Symons cone crusher and the minus-¼-inch product reduced to minus-12 mesh in a 3- by 4-foot Herman ball mill, equipped with a screen head. The minus-12-mesh ore constitutes table feed for three 5- by 14-foot concentrating tables, two of which are Straub Overstrom tables and the other a Wilfley. The concentrate is dried and elevated to a storage bin for feed to a Stolle magnetic separator which removes the garnet. The concentrate can be roasted if the sulphide content is too great. Mill capacity is 1½ tons per hour.

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[152] Bateman, Paul C., Erickson, Max P., and Proctor, Paul D., op. cit., pp. 23-42, 1950.

The mill is run intermittently by one man from the mine crew. Power is supplied by the California-Nevada Power Company.

Equipment at the mine includes an Ingersoll-Rand tugger hoist, a Sullivan HS 15 diamond drill (EX), a Sullivan portable compressor, 105-cubic-foot capacity, and a gasoline-motor-powered generator, 2.5 KW.

Three to five men are working, including Otis A. Kittle, and Gerald B. Hartley Jr., Engineer.

Sheepshead and Victory Tungsten Group. Location: 15 airline miles southwest of Furnace Creek Ranch in Trail Canyon; NE¼ T. 19 S., R. 45 E., M.D.M. (projected). Ownership: Milton L. Knapp, Palm Springs, California, and Floyd R. Bekins, Los Angeles, California.

Scheelite is in a stockwork of quartz veins, 2 inches to 2 feet wide, which are in limestone and in a tactite zone along a limestone-granitic rock contact. The limestone strikes northward and dips 25° E. Azurite, malachite and bornite are associated with the scheelite in the quartz stringers. Several prospect pits have exposed the tactite zone over a distance of 600 feet; the zone has an average width of 6 feet. The total mineralized area extends 800 to 1000 feet in length and 500 to 600 feet in width; assays range from 2 to 12 percent WO_3.

One ton of high grade ore was shipped in 1943. Further exploration of the property at that time was abandoned due to poor road conditions in Trail Canyon.

The property is idle.

Target Group (Victory Tungsten Syndicate). Location: In sec. 14, T. 8 S., R. 36 E., M.D.M. (?) at an altitude of 7500 feet. Ownership: 3 claims, the Target and Target No. 1 and Target No. 2, are owned by J. E. Babcock estate, Los Angeles, California, and Mr. Donahue, Big Pine, California.

Three parallel quartz veins in granite carry small bunches and lenses of scheelite. The property was operated by the Victory Tungsten Syndicate of Bishop during 1942-43. Ore was hauled by truck to Bishop. Estimated production is 200 tons of ore assaying 4 to 5 percent WO_3.

The property is idle.

Tungstar Mine (Crawford Deposit, Mt. Tom). Location: The mine is on the west shoulder of Mt. Tom in the SE¼ sec. 15, T. 7 S., R. 30 E., M.D.M. (projected) at an altitude of 12,000 feet. The millsite is near the junction of Gable Creek at Pine Creek in secs. 4 and 9, T. 7 S., R. 30 E., M.D.M. (projected). Ownership: 4 claims, the Mt. Tom Nos. 1, 2, 3 and 4, and the millsite are owned by the Tungstar Corporation, 6253 Hollywood Boulevard, Hollywood, California, G. F. Temple, president, Charles A. Greene, secretary.

The orebodies are two tactite lenses between granite and quartz diorite. Only the lower orebody, known as the Greene, has been extensively worked. There is an open cut on the other, the Stevens. In 1946 a cloudburst uncovered a third tactite lens above these two. There has been no work on this body, which is called the Owens.

The Greene orebody was about 100 feet long and 20 to 40 feet wide on the surface. The mine was originally worked by a 135-foot adit, a 100-foot intermediate level 50 feet above the adit and an open cut stope 30 feet deep, 30 feet wide and 100 feet long. Two raises aggregating 150 feet connected the levels. Through February 1941, approximately 17,000 tons of ore with an average grade of 2.6 percent WO_3 had been produced.[153]

Subsequently a shaft was sunk to a depth of 280 feet and mining operations were carried out from this on several levels. The collar of the shaft is 176 feet below the outcrop. A 52-foot vertical winze was sunk from the 280-foot level and a drift was run along the hanging wall for 86 feet. Two crosscuts showed the width of ore to be 23 feet and 12 feet with a grade of 2 to 4 percent WO_3.[154] A raise was run to make a second connection from the winze level to the 280-level. Some diamond drilling was done from the winze level and results were favorable.

The undeveloped Stevens orebody is 200 feet long and 30 to 95 feet wide at the surface. The distribution of the scheelite-bearing silicate zones in marble is irregular, and selective mining would probably not be feasible.[155]

Ore was transported from a 75-ton mine ore bin to the mill by a 11,800-foot aerial tram supported by 14 towers. The tram had a capacity of 100 tons per 8 hours. The buckets discharged into two 200-ton bins at the mill. The ore is crushed by a 10- by 30-inch jaw crusher and two 14- by 30-inch crushing rolls (one standby). Fine grinding is done in a 3- by 6-foot rod mill in closed circuit with a trommel and vibrating screen. The screen products are fed to eight concentrating tables via dewatering cones, each table operating on a sized-feed. Table tailings can be sent through a flotation section. Table concentrates are dried before going through a magnetic separator to produce a high grade concentrate. During 1943 and 1944, table concentrates represented about 75 percent of the total recovery, and flotation concentrates represented about 10.50 percent, making total recovery an average of 85.50 percent.

Operations were stopped on November 17, 1945 when a fire destroyed all the mine surface workings. The total production to that date was 70,774 tons with an average grade, based on mill recovery, of 1.967 percent WO_3.[156] During 1949 about 1000 tons of ore from the Black Rock mine in Mono County was milled, but the operation was not economic. The property is now idle.

Waucoba Tungsten Mine. Location: 19 airline miles northeast of Independence on the east slope of the Inyo Range in sec. 27 (?), T. 11 S., R. 37 E., M.D.M. Ownership: 2 unpatented claims are owned by Stuart Bedell, Big Pine, California.

Scheelite is in parallel bands in argillite interbedded with limestone and underlain by quartzite. Orebodies are small, irregular, and discontinuous, and both the ore and country rock are highly fractured. The area is cut by many faults. Granodiorite, not exposed underground, crops out north and west of the mine, and was probably the source of the ore-forming solutions.[157]

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[153] Lenhart, Walter B., Milling scheelite at Tungstar mine: Mining Cong. Jour., vol. 27, no. 4, pp. 67-71, April 1941.

[154] Thomason, Ira L., personal communication, 1950.

[155] Lemmon, Dwight M., op. cit., pp. 93-94, 1941.

[156] Thomason, Ira L., personal communication, 1950.

Work done at the mine consists of a 168-foot shaft inclined 55° NE. and two main levels 85 and 104 feet below the shaft collar. An intermediate level, which does not connect with the shaft, is about midway between the two levels in the northwest section of the mine. Workings total 700 feet in length. Most of the ore produced was from an area northwest of the shaft on the 80-foot level.

J. L. Danziger worked the property from 1939 to the fall of 1942. First milling was by dry concentration, later replaced by a mill which included primary crusher, rolls, screen and two Wilfley concentrating tables in series. Water was obtained from Waucoba Springs by means of a three-mile pipeline, financed by a Reconstruction Finance Corporation loan. Production figures are not available, but Danziger states that heads assays averaged between one and two percent WO_3. Concentrates were sold to the Molybdenum Corporation of America.

A massive quartz vein which crops out southeast of the shaft carries copper silicates and carbonates and $2.00 worth of gold per ton.[158] The mine was originally located as a copper prospect.

The property is idle.

Yaney Mine. Location: SW.¼ SW.¼ sec. 22, T. 7 S., R. 32 E., M.D.M., about 4½ airline miles southwest of Bishop. Ownership: 3 claims are owned by Eva L. Yaney, Bishop, California. Leased to B. W. Van Voorhis Jr., Bishop, California, and R. W. Adams, Lone Pine, California.

The mine was originally exploited as a gold mine. Tungsten was later discovered and the mine is now being worked for tungsten. The tungsten mineral recovered is ferberite, pseudomorphous after scheelite. The orebody is in the form of a pipe, with an elliptical cross section about 40 feet by 60 feet. The pipe rakes 45-degrees in a direction approximately S. 55° E. The ore, in a gangue of opaline silica, is in the contact zone between granitic rock and limey shale. The granite lies to the south and appears to have partially capped the deposit. Van Voorhis considers the deposit a contact metamorphic body containing scheelite which was intensely altered and replaced.

An adit has been driven S. 30° to 40° W. 225 feet; a 35-foot inclined winze, paralleling the direction of the pipe, has been sunk from the end of the adit. Above the adit level the pipe has been stoped nearly to the surface. A short adit, the floor of which is approximately 48 feet above the main adit, extends into the stope from an open cut. The pipe has been stoped or explored for 100 feet of inclined depth.

At first, the ore was slushed out of this upper adit. It is now being drawn down into the lower adit and trammed out to a loading bin. The ore is hauled 2½ miles by truck to the Bishop Antimony mine mill which has been leased. The ore is crushed in two crushers with a trommel between and passes through a jig to a small ball mill which grinds to 30 mesh. Both hutch and bed products are recovered from the jig. Minus 30-mesh material is split by a hindered-settling classifier into sand and slime products which go to separate 5- by 14-foot Deister tables. Capacity of the mill is approximately 2 tons per hour or 15 tons per 8-hour day. Concentrates are sold to the Molybdenum Corporation of America buyer in Bishop.

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[157] Private report made for J. L. Danziger, former operator.
[158] Tucker, W. B., and Sampson, R. J., op. cit., p. 467, 1938.

Mill equipment is driven by electric motors. Power is supplied by a 38 kw. generator driven by a Ford industrial engine. An Ingersoll-Rand 105-cubic-foot compressor is at the mine.

Three men are working.

Nonmetallic Mineral Commodities

Asbestos

Limestone outcrops on the west slope of the Inyo Mountains north of Keeler and in the Panamint Range south of Tin Mountain contain amphibole asbestos. Production has been small although the deposit south of Tin Mountain is now being exploited. The asbestos is ground for use as a filler in paint and stucco.

Barite

The mineral barite has been reported from many places in Inyo County,[159] but only one deposit, that in Gunter Canyon, has produced more than small amounts. No mines are active at the present time.

Clay

Bentonite and fuller's earth are the only types of clay produced in Inyo County. Both are composed largely of the montmorillonite group of minerals and are derived from the alteration of vitric tuffs, usually after deposition of the tuffs in bodies of water. Fuller's earth probably originates by further alteration of bentonite and is usually less plastic than bentonite.

Bentonite has been mined from deposits in the Shoshone and Tecopa areas, and from an area northwest of Death Valley Junction. Fuller's earth is now being mined from the Calearth deposit east of Olancha.

Calearth Clay Deposit. Location: On the southeast side of Owen Lake in secs. 13, 14, 23, and 24, T. 18 S., R. 38 E., M.D.M. (projected); about 9 airline miles south of Keeler. Ownership: 6 placer claims, Calearth 1, 2, 3, and 4, Oversight, and Lakeview, are owned by the Calearth Corporation, W. R. Cantley, president, Olancha, California and are leased to the Sierra Talc and Clay Company, 5509 Randolph Street, Los Angeles, California.

The Calearth deposit is a bed of "fuller's earth"[160] 16 feet in average thickness; the bed strikes N. 70° to 85° E. and dips 10° to 12° N. Tertiary basalt overlies the deposit.

The only claims being mined—those in section 23—have a 900-foot adit, driven S. 70° W. which functions as the main entry and haulage way. A winze 100 feet from the adit portal is the important vertical opening. The mining method used is room-and-pillar; drifts are extended from the winze, and raises from the drifts to give 40-foot pillars in the direction of dip of the clay bed, and 30-foot pillars in the direction of strike. The pillars will be removed later.

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[159] Murdoch, Joseph, and Webb, Robert W., op. cit., p. 65.

[160] Tucker, W. B., and Sampson, R. J., op. cit., p. 484, 1938.

All the openings have been timbered. A unique method, that of using pneumatic spaders, or ''clay diggers'' rather than the conventional drilling and blasting, is employed. Other equipment at the mine includes Ingersoll-Rand 105 and Chicago Pneumatic 105 air compressors. Air slushers are used underground to handle the clay.

Most of the clay produced is from underground workings, although some is mined from surface cuts. The clay is hauled by truck, on contract, to Olancha and shipped by rail to the company's grinding plant in Los Angeles. The clay is used for filtration and decolorization purposes.

Seven men are employed.

Side Hill Group. Location: 8 miles northwest of Death Valley Junction in secs. 18 and 19, T. 26 N., R. 5 E., S.B.M. Ownership: 4 patented claims are owned by Silicates Corporation, 230 Park Ave., New York 17, N. Y.

Two beds of bentonite each underlain by limestone and overlain by cemented volcanic ash were formed as an alteration product of volcanic ash. The beds strike N. 10° to 30° E. and dip 40° E. Surface work has exposed bentonite in beds as much as 10 feet thick.

Two inclined shafts, one 15 and one 40 feet deep, and several open cuts comprise the workings. One hundred tons of material has been shipped for experimental purposes.

Feldspar

Feldspar production in Inyo County has been from deposits on the eastern slope of the Sierra Nevada; large bodies of the mineral are in dikes enclosed in granitic rocks. In the low hills east of Big Pine, feldspar is mined from a deposit consisting almost wholly of feldspar, altered in places to kaolin. Deposits in the southwestern corner of the county are composed of massive bodies of quartz and feldspar.

Nebicite Feldspar-Kaolin Deposit (Big Pine Kaolin Deposit). Location: 3¼ airline miles N. 58° W. of Big Pine in sec. 2, T. 9 S., R. 33 E., M.D.M. on the west side of Owens Valley. Ownership: 4 claims are owned by Stuart Bedell and J. W. Newman of Big Pine.

Feldspar, partly altered to kaolin, occupies a shear zone in granite. The zone strikes N. 10° E., dips 60° to 70° W. and varies in width from 10 to 25 feet. Much of the feldspar exposed is partly altered to kaolin, and nearly pure kaolin is concentrated along the hanging wall.

An adit driven south along the strike for 75 feet is 20 feet wide in places; from this adit, 1000 tons of material has been mined for use as filler.

Equipment consists of a 110-cubic-foot compressor, a ¾-ton car and a 25-ton circular ore bin.

The property is idle.

Sierra White Feldspar Deposit. Location: 3 airline miles N. 70° W. of Big Pine in sec. 11 (?), T. 9 S., R. 33 E., M.D.M. on the west side of Owens Valley. Ownership: 2 claims are owned by Huntley Industrial Minerals, Incorporated, Box 305, Bishop, California.

A feldspar dike, striking N. 10° E. and dipping 70° W., is in a fracture zone in granitic rock. The width of the deposit varies from 10 to 30 feet along the strike, and the deposit is offset by minor cross-faults with maximum displacements of 6 feet.

The deposit is mined by several open cuts; the south and largest one is 125 feet in length and 50 feet deep at the present working level. Two-hundred feet north of this is an open cut 75 feet long and 40 feet deep. These two quarries and a smaller one 1500 feet farther north have produced 4000 tons of feldspar to February 1950. Present production is 300-450 tons per month.

Two men are employed.

Fluorite

Fluorite is a gangue mineral in the lead-silver deposits in the Cerro Gordo, Darwin and other districts.[161] Although low-grade deposits of fluorite are known in Warm Springs Canyon and other places in the Panamint Range, only the Warm Spring Canyon deposit has been worked, but the isolation of even this deposit has made mining of the fluorite uneconomic.

Garnet

Garnet is an accessory mineral in nearly all of the scheelite-bearing tactite deposits. In the normal tungsten milling operations, garnet is removed from the gravity concentrate by means of electrostatic separators. The garnet so separated has been saved and marketed by some of the tungsten-producing companies. In recent years, garnet has been produced from old tailings by the Huntley Industrial Minerals, Incorporated (see text under tungsten).

Limestone[162]

Deposits of limestone and dolomite are abundant in Inyo County, but few have been exploited. In the southeastern part of the county, near Shoshone, a great thickness of Paleozoic limestone and dolomite has been measured, but has never been quarried; [163] the limestone and dolomite sections in the Argus and Panamint Ranges and the Darwin Hills contain lead-silver-zinc deposits which are mined, but only small amounts of limestone have been shipped. However, the limestone and dolomite of the Inyo Range, which also serve as host rocks for lead-silver minerals, have been extensively mined for limestone.[164] The Inyo Marble Company, which operated the quarry, produced commercial marble in white, gray, yellow, and black colors for dimension stone. The Inyo Range contains limestone and dolomite ranging in age from Cambrian to Triassic, but deposits of the Silurian and Devonian systems only are quarried.

The largest limestone-mining operation in the county is that of the West End Chemical Company in the Slate Range. The dolomitic limestone mined there is burned to produce carbon dioxide for the carbonation process in the company's brine plant on Searles Lake, San Bernardino County.

Tertiary travertine on the east side of Death Valley is well exposed in Furnace Creek Canyon. Onyx marble has been produced from the Argus Range west of Ballarat, and a marble deposit is worked in the low hills east of the Inyo Range.

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[161] Murdoch, Joseph, and Webb, Robert W., op. cit., p. 146.

[162] Dolomite, marble, onyx marble and travertine are also included in this section.

[163] Hazzard, John C., Paleozoic section in the Nopah and Resting Springs Mountains, Inyo County, California: California Div. Mines Rept. 33, pp. 273-339, 1937.

[164] Logan, Clarence A., Limestone in California: California Jour. Mines and Geol., vol. 43, pp. 242, 244-245, 1947.

Amargosa Marble Company's Travertine Deposit. Location: 2¾ miles east of the junction of State Highway 190 and Ryan Road in Furnace Creek Canyon or 12 miles southeast of Furnace Creek Inn in Death Valley. Ownership: 40 acres were leased in 1948 by Jack Rogers and Emory Arnold, Death Valley Junction, from Pacific Coast Borax Co., 510 W. 6th St., Los Angeles.

Travertine beds cropping out north and south of the highway strike N. 20° W. and dip 20° E. A small plant consisting of a jaw crusher and screens produced terrazzo chips from several open cuts on the north side of the highway.

The property is idle.

Death Valley Onyx Deposit (Onyx marble). Location: 9 airline miles west of Ballarat in Shepherd Canyon on the lower slope of the Argus Range; sec. 6 (?), T. 22 S., R. 43 E., M.D.M. (projected) Ownership: 2 unpatented placer claims, Death Valley Onyx and Death Valley Gem Onyx, are owned by H. C. Degner, Beverly Onyx-Marble Co., 623 N. La Peer St., West Hollywood, California.

Layers and bands of onyx marble, having an aggregate thickness ranging from 3 to 7 feet, are in limestone; altered rhyolite crops out on the west of the deposit. Beautifully banded, mottled, and cloudy structures in a variety of colors, including green, red, brown, and cream, make the polished material an outstanding product.

The deposit has been worked by two quarries, one at the top of an isolated knob and the other 500 feet east and down the slope of the hill. The owner estimates 70,000 tons of material available from developed areas. Additional exploratory work, particularly drilling, would probably increase this figure.

The deposit was located in 1925 and has been worked intermittently since that time. Total tonnage produced is not available, but probably does not exceed 500 tons.

Inyo Marble Company. Location: Along the southwestern flank of the Inyo Range from 2 to 8 miles northwest of Keeler in secs. 4, 10, 11, 13, 14, 24, 25, T. 16 S., R. 37 E., M.D.M., (projected) and secs. 19, 30, 31, T. 16 S., R. 38 E., M.D.M. (projected). Ownership: Inyo Marble Company, D. H. Dunn, president, 728 E. 29th St., Los Angeles, owns 24 association placer claims. Of these, patents have been issued for 140 acres in sec. 4, 320 acres in secs. 10 and 11, 200 acres in sec. 14, 120 acres in sec. 24 and 40 acres in sec. 25, all in T. 16 S., R. 37 E., M.D.M. (projected) and 200 acres in sec. 19 and 120 acres in sec. 30, both in T. 16 S., R. 38 E., M.D.M. (projected).[165] The property is leased to Dolomite Products, Inc., Mr. H. Matt, 510 W. Garfield, Glendale 4, California.

Silurian and Devonian dolomite in a series of Paleozoic marine metasediments has been exploited along a belt half a mile wide and six miles long. The history of the deposit has been summarized by Logan.[166]

Several colors of dolomite are available for terrazzo chips but the principal production in recent years has been white for roofing granules. Chemical analyses of the marble show the material to be nearly a pure dolomite. An analysis made by the State Mining Bureau in 1890 showed

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[165] Logan, C. A., op. cit., p. 244.
Dunn, D. H., oral communication, March 1950.
[166] Logan, C. A., op. cit., pp. 244-245.

54.25 percent $CaCO_3$, 44.45 percent $MgCO_3$, and 0.60 percent iron and silica.

The dolomite is mined in open cuts and hauled by truck to the crushing and screening plant at Dolomite Siding on the Keeler branch of the Southern Pacific railroad. The crude ore is crushed in a 9- by 12-inch jaw crusher. Crushed ore is passed through a trommel to a multideck vibrating screen. The normal roofing granule size is minus 4- plus 10-mesh. If terrazzo material is being made, the sizes are:

Trade size No. 4	minus 4- plus 6-mesh
Trade size No. 6	minus 6- plus 8-mesh
Trade size No. 8	minus 8- plus 10-mesh

Some minus 32-mesh to pan dolomite has been sold for use in rock wool manufacture. Other uses include plaster sand and chicken grit.

The screened product is bagged in 100-pound bags and hauled by truck or railroad to the Los Angeles area. Plant capacity is 300 to 400 tons per month. Since November 1948 the property has been operated under lease by the Dolomite Products, Inc., H. Matt, president, 510 W. Garfield, Glendale 4, California. The company plans to enlarge the plant capacity to 300 tons per week. Ten men are employed.

J. D. G. Marble Claims (Emily May, Betty Ann claims). Location: 14 airline miles S. 74° E. of Keeler in sec. 27, T. 17 S., R. 40 E., M.D.M. (projected). Ownership: 5 association, unpatented mining claims totaling 300 acres are owned by John R. Powers, 301 N. Arden Blvd., Hollywood, Dale Pursell and Harold E. Gohegan.

The deposit consists of extensive beds of metamorphosed limestone which vary in strike and dip. Adjacent to the Lee's Flat Road at the mouth of Marble Canyon, the marble beds strike N. 20° to 45° E. and dip steeply nothwestward. The marble is black, grey, and red with veins of several other colors. Polished samples indicate a high quality product.

West End Chemical Company Limestone Quarry. Location: 13 miles north of Trona in secs. 9, 10, and 15, T. 23 S., R. 43 E., M.D.M. Ownership: 12 patented claims totaling 377 acres are owned by West End Chemical Company, 608 Latham Square Building, Oakland, California.

Nearly flat limestone beds have been exposed to a depth of 130 feet in the present quarry, which covers 2 acres. Total thickness of the beds is unknown. Originally the quarry was opened as a sloping hillside operation. At present, two benches are being worked. Wagon drills are used for primary drilling and jackhammers for secondary drilling.

Quarried limestone is hauled a few hundred yards in Euclid 10-yard dump trucks to a Traylor 28- by 36-inch jaw crusher. The crushed stone then passes over a Simmons 4- by 6-foot vibrating screen. The minus $1\frac{3}{4}$-inch material, amounting to 22 percent of the crushed stone, goes to the waste dump, and the $1\frac{3}{4}$- by 6-inch material is conveyed to a 450-ton storage bin. Small amounts of slate and silica inclusions are sorted out as the stone is conveyed from the vibrating screen to the storage bin. The final product is trucked 18 miles to the West End Chemical Company plant at West End where it is burned to furnish carbon dioxide in the plant operation.

Fifteen men are employed at the quarry in the production of 450 tons of limestone per day under the supervision of C. E. Ousley, quarry superintendent. H. D. Hellman is plant manager at the West End plant.

Mica

Scrap mica has been produced intermittently from a pegmatite deposit in the Amargosa Range near Bradbury Well. The usefulness of the product has been limited by the associated quartz which is not easily separated.

Death Valley Mica Mines (Pegma Mine). Location: In the Amargosa Range, about 1 mile southeast of Bradbury Well, approximately in secs. 23, 24, T. 21 N., R. 4 E., S.B.M. (projected). Ownership: 3 unpatented claims are owned by Louise Blossom, 2351 N. Garfield, Altadena, California. Under lease to Death Valley Mica Mines, J. E. Carol and G. O. Mosbarger, Shoshone, California.

Muscovite mica, suitable for scrap only, is in a pegmatite which trends northeastward and dips at a high angle to the southeast. Prior to work done by the present lessees, the mines consisted of several shallow trenches and a 22-foot shaft with a 20-foot crosscut at the bottom. In 1949 a 60-foot crosscut was driven to intersect the shaft which had been deepened 10 feet.

A 20-ton mill has been erected to produce the scrap mica. It consists of an impact mill, cyclone collector and vibrating screens in closed circuit. Six sizes of mica are produced: plus 20-, 40-, 60-, 80-, and 100-mesh and minus 200-mesh. The products are bagged in 100-pound bags. Total production has been about 350 tons, of which 150 tons has been produced by the present lessees.

Equipment in addition to the mill, which is powered by a Chevrolet gasoline motor, includes a 60 HP Rix compressor. Two men are working.

Perlite, Pumice, Pumicite, and Volcanic Cinders[167]

Inyo County produces considerable amounts of perlite, pumice, pumicite, and volcanic cinders. These valuable building, chemical, and industrial materials are finding ready markets in California, and are being shipped to consuming centers elsewhere in the United States.

All of these materials are products of volcanic activity which ranges in age from late Tertiary to Recent. Several of the source vents from which some of them came are visible, but the vents for others are probably covered, and their approximate position is marked by thick accumulations of lava and other volcanic debris.

Although the production of pumice and pumicite in Inyo County dates back many years before World War II, it is only within recent years that there has developed a perlite industry, and a substantial production of expansible perlite rock.

Effective use of volcanic cinders as aggregate in building blocks and construction has promoted the exploitation of this valuable, nonmetallic industrial material.

Perlite. Perlite is a name applied to those volcanic glasses which are characterized by "onion-skin" fracture and a water content that ranges from 0.1 to 6.0 percent. Many perlite rocks, as well as other siliceous volcanic glasses which do not have the perlitic structure, will expand into light-colored, frothy material of low density. This expanded perlite is of considerable economic value, especially as a lightweight aggregate in accoustical and insulating plasters, as an abrasive agent in scouring soaps and cleansers, as filler in rubber and paints, and also as a filter aid, insecticide carrier, and soil conditioner.

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[167] This section has been prepared by Charles W. Chesterman, Associate Mining Geologist, California Division of Mines.

There are several deposits of expansible perlite in Inyo County. Some of these deposits are close to existing railway lines and paved highways, whereas others, especially those in the southern part of Death Valley, are distant from railways and other forms of economic transportation. The bulk of the present production of perlite rock comes from deposits west of Fish Springs, about 7 miles south of Big Pine. Other deposits have produced small amounts, but only for testing purposes.

In numerous places in Inyo County, the perlite occurs as flows associated with flows of rhyolite, andesite, and basalt, and beds of agglomerate, breccia, and tuff. Those deposits near the southern end of the Coso Range are in the form of volcanic domes.

Brooke Perlite Deposit. Location: Secs. 24 and 25, T. 10 S., R. 33 E., and secs. 29 and 30, T. 10 S., R. 34 E., M.D.M., 7 miles south of Big Pine and 3.5 miles west of Fish Springs. Ownership: 8 claims are owned by Mr. Douglas Robinson and Mrs. Lunsford Yardell of Bishop, California; Mrs. Laura Bulmer, Reno, Nevada, and Mrs. Dottie Wilson, Big Pine, California. Leased to Mr. Arthur Detloff, Big Pine, California.

Brooke perlite property occupies a large part of the hill on which the Fish Springs perlite deposit is located. The general geology and varieties of perlite on the Brooke property are identical with those found in the Fish Springs deposit. The Brooke property has been prospected through a series of shallow trenches and test pits which expose the various kinds of perlite rock. Although no perlite rock has been produced from this property, a crushing and screening plant is being constructed.

Coso Perlite Deposits. Location: T. 21 and 22 S., R. 38 E., M.D.M., about 7 miles northeast of Coso Junction and 2 miles west of Coso Hot Springs in the southeastern part of the Coso Range. Ownership: Within U. S. Naval Ordnance Test Station, Inyokern.

The perlite occurs as domes and short coulees which rest upon deeply eroded granite rocks of the Sierra Nevada batholite. The domes are conical-shaped masses of perlite that rise an average of 300 feet above the low-lying granitic hills. They range in diameter at their bases from 2000 to 6000 feet. Although the slopes of the domes are steep, they are covered at their lower part by a mantle of loose, angular, talus blocks. The upper surfaces of the domes are uneven, and are covered by sharp-crested ridges of angular blocks and collapsed spines. The perlite is a light gray, greenish rock, which, in places, is more or less pumiceous. Flow banding is well developed. The perlitic structure is present throughout the masses, but is much better developed in less pumiceous areas. Closely associated with the perlite are lens-like bodies of black obsidian, which in places grade into perlite and pumiceous obsidian.

Expansion tests performed on the different varieties of perlite rock from Coso area indicate that the material is suitable for making lightweight aggregate. There has been no perlite produced from this area.

Fish Springs Perlite Deposit. Location: Secs. 19 and 30, T. 10 S., R. 34 E., M.D.M., 7 miles south of Big Pine and 3 miles west of Fish Springs. Ownership: Morris Albertoli, 2702 Glendale Boulevard, Los Angeles, and M. Frey, Los Angeles, own 4 claims which were leased to H. Denbigh Ellis, 650 S. Spring Street, Los Angeles, California (1948).

Fish Springs perlite property is at the eastern end of a conspicuous hill near the base of the Sierra Nevada. The hill is elongate in plan and trends in an easterly direction. It rises about 100 feet above its base of outwash alluvial material. The hill is composed almost wholly of glassy volcanic rocks. The rock at the top is pumiceous perlite, which grades downward into a more or less flat-lying zone of slightly pumiceous perlite about 40 feet in thickness. The perlite rests upon brecciated obsidian, which rests upon a dense, glassy, perlitic vitrophyre (see pl. 12*B*). The only overburden is the highly pumiceous perlite, and much of it will expand.

The perlite rock is mined in an open cut by a small power shovel loading into trucks which haul the perlite to a crushing and screening plant at Loco, a siding on the Southern Pacific Railroad 21 miles north of Little Lake (see pl. 13*B*). At the crushing plant, the perlite rock is crushed in an impact crusher and elevated to a trommel where two products are separated, minus-12 mesh to plus-50 mesh and minus-50 mesh, and stored in a 24-ton, two-compartment bin. The oversize fragments return to the crusher for further crushing. Crushed perlite rock is bulk loaded into railroad cars and trucks. The mill can process 30 tons in an 8-hour day.

Sheephead Mountain Perlite Deposit. Location: In the western part of T. 21 N., R. 5 E., S.B.M., about 8 miles southwest of Shoshone on the east flank of Sheephead Mountain. Ownership: Harry Gower and Donald Seal, Death Valley Junction, California.

The east side of Sheephead Mountain is made up of a series of lava flows and tuffs that dip rather steeply toward the east and strike about N. 15° E. A section near the deposit includes the following:

Rock	*Description*	*Estimated Thickness*
Perlite	A light gray to greenish-gray rock having splintery and subconchoidal fracture, and containing small amounts of quartz, orthoclase, and biotite.	25-50 feet
Rhyolite	A pink to grayish porphyritic rock. In places spherulitic, dense, and vesicular.	25-50 feet
Rhyolite breccia	A greenish-gray fragmental rock made up of angular fragments of rhyolite in a compact matrix of tuff. Opalized in places.	20-60 feet
Rhyolitic tuff	A light-colored, cream to dull brick-red, fine-grained rock. Locally altered and opalized.	50-70 feet

The best grade of perlite rock is exposed at the base of Sheephead Mountain, where the perlite flow ranges in thickness from 25 to 40 feet. It rests upon opalized tuff which overlies the perlite rock described in the above section. The basal part of this perlite flow is brecciated and contains short transecting fractures filled with opalized tuff. The perlite flow is overlain by an accumulation of opalized tuff and breccia. No perlite has been mined from this property.

Shoshone Perlite Deposit. Location: secs. 26 and 35, T. 22 N., R. 6 E., S.B.M., about 2 miles west of Shoshone on the east side of the Dublin Hills. Ownership: 21 lode claims are owned by Ed Grimshaw, Tecopa, California; A. W. Stalker, and Walter Davis, Shoshone, California. Leased in 1948 to Perlite Industries, Inc., C. H. Harrington, president, 2332-3rd Avenue, Los Angeles 16, California.

The Dublin Hills are made up of lava flows, tuffs, and breccias that rest on Paleozoic sedimentary rocks. In general, the perlite is in lenticular flows and irregular bodies resting on tuffs and breccias. The perlite is overlain by and grades into spherulitic and vesicular rhyolite. The upper part of the perlite flow is spherulitic and contains numerous lithophysae wholly or partly filled with quartz, chalcedony, and calcite. The perlite is light to dark greenish-gray in color and contains sparse crystals of quartz, orthoclase, and biotite. In places, the perlite at the base of the flow is pumiceous and brecciated. The tuff underlying the perlite is locally altered to opalite.

Southern Death Valley Perlite Deposit. Location: About 22 miles south of Furnace Creek Inn, and 4 miles southwest of Bennetts Well, Death Valley National Monument at an altitude of 1500 feet. Ownership: Harry Gower, Tom Wilson, and Donald Seal, Death Valley Junction, California own 4 claims.

The perlite is a flow of variable thickness, and dips steeply toward the east into Death Valley. It is overlain by a flow of dense, porphyritic rhyolite, and rests upon rhyolitic tuffs and agglomerates. The perlite is light gray in color. In places, it is soft and pumiceous; in other places it is a dense, glassy rock. It always exhibits a well-developed perlitic structure and will expand into a good grade lightweight aggregate. No perlite rock has been produced from this property.

Staats Perlite Deposit. Location: In the southern part of T. 18 S., R. 38 E., M.D.M., about 13 miles south of Keeler, California at the northern end of the Coso Range. Ownership: D. E. Staats, Keeler, California owns 1 claim.

The perlite occurs as a plug-dome which intruded flat-lying tuffs, agglomerates, and andesitic lava flows. The dome is more or less circular in plan with a mean diameter of about 600 feet. It rises about 100 feet above the surrounding, low rounded ridges. The outer part or rim of the dome is made up of light gray perlite which contains, near its contact with tuffs and agglomerates, numerous rounded fragments of black obsidian. The perlite zone is about 10 feet thick and grades inward into an extremely pumiceous perlite at the center of the dome. A small, irregular body of tan-colored rhyolite is at the northwestern edge of the dome.

Other perlite deposits in Inyo County include those at Salisbury Pass, about 12 miles west of Shoshone, and in Grapevine Canyon.

Pumice. Pumice is a cellular, glassy, volcanic rock, formed by rapid expansion of water vapor contained in acidic lavas at high temperature, through rapid relief of pressure as the lava approaches the surface of the earth. Pumice varies in color from white to gray, yellowish, pinkish, and brownish, and some specimens have a silky lustre. It rarely forms large rock masses, but usually forms the upper crust of rhyolitic lava flows or is in fragments among other volcanic ejecta expelled from volcanoes. The fragments making up the volcanic ejecta range in size from dust-like particles to blocks several feet in diameter. Such fragmental volcanic rocks, composed essentially of small fragments of pumice, rock, and grains of quartz, feldspar, and biotite, are referred to as tuffs. Tuffs are usually in the form of beds or mantle-like deposits and are variable in thickness.

Pumice can be roughly classified according to size, as follows: (1) pumicite, often referred to as volcanic ash, is the fine, loosely compacted, dust-like material; (2) lump pumice, rounded and angular fragments of pumice ranging from particles $1/16$ inch to 2 inches in diameter, and (3) block pumice, large, angular or rounded masses of pumice measuring as much as several feet in diameter. Each of these sizes has specific uses and demands. Pumicite is used primarily as an abrasive in scouring soaps and cleansers. Lump pumice is used as an aggregate in concrete and plaster. Block pumice is sawed into blocks of certain dimensions and used as griddle cleaners. The largest outlet, however, is for the lump pumice, which is used as light-weight aggregate for all types of pre-cast and poured building units.

The bulk of lump pumice for aggregate purposes comes from deposits near the southern part of the Coso Range. The pumicite, or volcanic ash, comes from extensive deposits near Shoshone.

California-Nevada Building Materials Producers Pumice Deposit. Location: Sec. 19, T. 21 S., R. 38 E., M.D.M. on the southeast slope of the Coso Mountains. Ownership: R. H. Thompson, Mayfair Hotel, Inyokern, California owns three 20-acre placer claims. Property leased by California-Nevada Building Materials Producers, D. B. Chester and associates, 3723 Wilshire Boulevard, Los Angeles, California.

The pumice lies on the north slope of a small canyon and was being developed in August, 1949. Plans call for installation of a screening plant north of Coso Junction adjacent to the highway.

Desert Materials Corporation Pumice Deposit. Location: Secs. 13, 14, 21, 22, 23, 24, and 35, T. 21 S., R. 38 E., M.D.M., about 6 miles northeast of Coso Junction in the southern part of the Coso Range. Ownership: 17 claims are owned by the Desert Materials Corporation, H. Thogwell, president, 6371 Wilshire Boulevard, Los Angeles 36, California.

This property is near the Coso perlite deposits. The pumice deposits are large and may be grouped into two types, depending on whether they were deposited under subaqueous or subaerial conditions. The pumice in these two types of deposits is similar in physical properties, and has been used for similar purposes.

The tuffs of subaqueous origin are in well-bedded deposits that contain beds of pumice separated by layers of gray, more or less consolidated sand. The tuffs range in thickness from 1 foot to 60 feet, and rest unconformably upon a deeply eroded granitic basement. The pumice fragments vary in size from $\frac{1}{4}$ inch to $2\frac{1}{2}$ inches; the average is approximately $\frac{3}{4}$ inch. The pumice is grayish-white in color, and contains flakes of brown biotite, and grains of quartz and feldspar. Scattered throughout the tuff are angular and rounded boulders of decomposed and fresh granite, basalt, andesite, and schist.

The tuffs of subaerial origin lack the stratification found in those of subaqueous origin. Bedding is poorly defined, and the characteristic feature of the tuffs of subaerial origin is the heterogeneous arrangement of the pumice fragments, weathered and fresh granite, basalt, andesite, and schist. The two types of deposits are similar, however, in that pumice fragments vary in size from $\frac{1}{4}$ inch to 2 inches; the average is about $\frac{3}{4}$ inch. This pumice, too, is grayish-white in color, and contains brown plates of biotite, and grains of quartz and feldspar. The tuffs are variable in thickness, ranging from 1 foot to 30 feet, and rest upon a basement of granite.

Present mining operations are being carried out in one of the larger deposits of subaerial pumice, although considerable pumice was mined from the subaqueous tuffs. The present pit measures approximately 1000 feet long and 600 feet wide. The pumice bed is approximately 30 feet thick, and is covered by about 8 feet of overburden. The pit was dug by a $2\frac{1}{2}$-yard Link-Belt dragline, and the pumice loaded into 40-yard diesel-powered trucks which hauled it to the screening plant about 9 miles away.

At the screening plant, at Sykes siding on the Southern Pacific Railroad, in sec. 11, T. 22 S., R. 37 E., M.D.M. (projected), the mine run material is passed over a 3-inch grizzly to remove the boulders of granite, basalt, andesite, and schist. The minus 3-inch material goes to a 3-deck Overstrom vibrating screen and a 2-deck Overstrom vibrating screen, all in a closed circuit with an 18 by 30 inch Universal roll crusher. The screen sizes are varied according to the product desired. A few of the products and approximate screening capacities are given below:

Product	*Size in inches*	*Yards per hour*
Pea gravel	$-\frac{3}{8} + \frac{1}{8}$	85
Block aggregate	—5/16 to pan	85
Gunite aggregate	—3/16 to pan	40–45
Plaster granule	$-\frac{1}{8}$ + 1/16	--
Plaster sand	$-\frac{1}{8}$ to pan	45
Special sand	1 and $\frac{3}{4}$	110–115

Finer grades of material are stored in bunkers, and the coarser grades are kept in storage yards.

Inyo Pumice Corporation Deposit. Location: Sec. 19, T. 21 S., R. 38 E., M.D.M. on the west side of Coso Range and south of Haiwee Reservoir. Ownership: 2 claims are owned by William J. Petty, P. O. Box 21, Inyokern, California, and leased to Inyo Pumice Corporation, N. W. Baum, president, 11314 S. Luitwieler Road, Whittier, California.

The pumice occurs in a well-bedded tuff bed that dips gently toward the west. The pumice is overlain by a well-cemented, cream-colored, sandy tuff. The pumice fragments are angular and range in size from $\frac{1}{4}$ inch to 2 inches. Thickness of the pumice beds is not known, although preliminary tests indicate it to be at least 30 feet. The property is being prepared for mining by bench cutting (1949).

Jamieson Pumice Deposit. Location: Sec. 8, T. 8 S., R. 34 E., M.D.M., about 7 miles north of Zurich on the east side of Owens Valley at the base of Black Mountain. Ownership: Several claims are owned by Alexander Jamieson, Big Pine, California and leased to H. W. Frey and R. W. Bidwell, Los Angeles, California.

The pumice bed, ranging from 6 to 10 feet in thickness, is interbedded with fanglomeratic materials which dip gently toward the west into Owens Valley. The pumice fragments are angular and range in size from 1/16 inch to 1½ inches. The pumice is white, and contains grains of quartz and feldspar. Approximately 20 percent of the pumice bed is angular and sub-rounded grains of quartz and feldspar.

The pumice was mined by open cut methods, which required that the fanglomeratic material making up the overburden be stripped before any pumice could be removed. Mine run pumice was hauled to a screening plant near the pit. (Plate 13*A*). The following screen sizes were produced: minus 1½ inches, plus ⅜ inch, and minus ⅜ inch.

The property is idle.

Oasis Pumice Deposit. Location: T. 6 S., R. 37 E., M.D.M., near Westgaard Pass road, about 3¼ miles south of Mono County line. Ownership: Francis E. Patton and F. S. Longley.

A pumice bed of undetermined thickness was exposed in a pit 30 by 20 feet. The pumice fragments are angular, and white. The bed contains considerable amounts of sand composed of quartz and feldspar.

The property is idle.

Round Mountain Pumice Deposit. Location: Sec. 19, T. 21 S., R. 38 E., M.D.M., about 2 miles east of Camp Dunmovin on the southwest slope of the Coso Range. Ownership: 3 claims are owned by Henry Babineau, 6204 Woodward Avenue, Bell, California.

The pumice is in a lenticular bed of unknown thickness which dips gently toward the west. The bed is approximately 20 feet thick at the center of the open pit. The pumice fragments are white, angular, and range in size from ¼ inch to 2 inches. The pumice is unconsolidated and easily mined.

Mining operations were started in February, 1949 on a small ridge. The overburden of variable thickness was stripped to expose the pumice. The pumice is mined with an International T-9 tractor with a hydraulic dozer which pushes the pumice into a hopper. This feeds onto a vibrating screen driven by a 6 HP gasoline engine. The following sizes of pumice are produced: minus 1½ inches, plus ⅜ inch, and minus ⅜ inch. Production in 1949 was approximately 2500 tons of pumice.

Shoshone Volcanic Ash Deposit. Location: Secs. 30 and 31, T. 22 N., R. 7 E., S.B.M., about ¼ mile southwest of Shoshone, California. Ownership: Charles Brown, Shoshone, California owns 480 acres which are leased to Western Talc Company, F. H. Savell, president, 1901 E. Slauson Avenue, Los Angeles, California.

The volcanic ash, properly called pumicite, is in a flat-lying bed that averages 12 feet in thickness. It is overlain and underlain by sands and gravels of Pleistocene age. The pumicite is grayish-white in color and loosely compacted. The overburden is cemented in places with a siliceous cement, and is as much as 12 feet in thickness. (See Plate 12*A*.)

The overburden is first removed by scrapers and bulldozer, and then the pumicite is loaded into a 20-ton truck with a Caterpillar elevator loader. Mine run material is hauled to Western Talc Company's grinding plant at Dunn, a siding on the Union Pacific Railroad, where it is loaded into railroad cars, or dried, pulverized, and sacked for shipment to manufacturers of cleansers and scouring soaps.

Mining operations are intermittent, depending upon the demand for the pumicite. Production for the 4-year period 1944-47 was approximately 6000 tons. Present output is about 160 tons per month.

Van Loon "fines" Pumice Deposit. Location: Secs. 8 and 18, T. 6 S., R. 33 E., M.D.M., 5 miles north of Bishop, California, at the southern edge of the Volcanic Tableland and about 2 miles south of the Mono County line. Ownership: H. A. Van Loon, Bishop, California owns 540 acres.

The pumice occurs in a flat-lying bed that is overlain by the Bishop tuff.[168] The thickness of the pumice bed is not known, but it is at least 30 feet thick, as indicated by test pits and other places where the pumice has been exposed (pl. 18*B*).

The Van Loon deposit contains more pumicite than pumice. The material ranges in size from angular, dust-like particles to well-rounded lumps as much as 4 inches in diameter. The average size, however, is probably less than 1/16 inch. The pumice has a pale, pinkish-brown color. Many fragments of quartz and feldspar are scattered throughout the bed, and are phenocrysts in the lump pumice. The material is poorly sorted and loosely compacted.

The Bishop tuff that lies immediately above the pumice bed is compacted, but is not as dense or compact as it is several hundred feet higher in the section where it has been welded into a dense, rhyolite-like rock. However, only the less compacted part of the Bishop tuff, which can be removed easily by scraper and bulldozer is being mined.

Mining is by bulldozer, which pushes the pumice directly into a bin. From the bin, the mine-run pumice passes through a vibrating screen which separates the plus ½ inch material from the minus ½ inch material. The oversize is piled and discarded. The minus ½ inch material is loaded directly into trucks and hauled to Bishop where it is mixed with coarser pumice for making slabs, building blocks, or is sold on the open market.

W-W Pumice Company Deposit. Location: Secs. 18 and 19, T. 21 S., R. 38 E., M.D.M., 3 miles southeast of Haiwee Reservoir on the southwestern flank of the Coso Range. Ownership: 8 placer claims are owned by William J. Petty, P. O. Box 21, Inyokern, California and leased to W-W Pumice Company, William Wainscott, president, 4040 Wilshire Boulevard, Los Angeles, California.

The bed of pumice lies near the base of a thick section of volcanic rocks which includes flows of andesite, basalt, and andesitic tuffs and agglomerates, and rhyolitic tuffs. The top, or upper part of the section, is a flow of dark, greenish-gray andesite porphyry that dips gently toward the west. Below the andesite are thick and thin beds of tuff and agglomeratic tuff which include beds of compact rhyolitic tuff. At the base of the section, which is only partly exposed, there is a bed of light, creamy-white pumice. The thickness of this bed is not known, although thicknesses up to 30 feet have been exposed in test pits. Lying above the bed of pumice is a tuffaceous agglomerate ranging in thickness from 3 to 15 feet.

The pumice is mined by open pit methods and is moved to a grizzly hopper by an Allis Chalmers HD-14 tractor equipped with a Baker angledozer. Material from the hopper passes by conveyor belt to another bin, where it is fed by a Stephens-Adamson plate feeder onto a 4- by 8-foot double deck vibrating screen. The screening circuit is closed and includes a set of 10-inch Sturtevant rolls for crushing the oversize. Screens are changeable and only one size, $\frac{5}{16}$ inch, is in use. The minus $\frac{5}{16}$-inch material goes to another set of screens over the truck-loading storage bin, which is divided into 4 compartments for the different sizes. Electric power is supplied by a 50 kw Caterpillar diesel generator.

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[168] Gilbert, C. M., Welded tuff in eastern California: Geol. Soc. Am. Bull., vol. 49, pp. 1829-1862, 1938.

Volcanic Cinders. Volcanic cinders differ from pumice in chemical composition, physical appearance, and mode of accumulation. Cinders are usually basaltic in composition. They are crystalline, not glassy, and are made up of small crystals of plagioclase and pyroxene. The cinders vary in color from red to reddish-brown and black. They are coarsely cellular and occur in angular and rounded fragments ranging in size from $\frac{1}{8}$ inch to 6 inches. Most cinder deposits are in the shape of volcanic cones built up by repeated volcanic outbursts around a central opening.

Red Cinder Mountain is a volcanic cinder cone which stands out conspicuously above the lava field at the southern end of Rose Valley, and rises about 500 feet above its base to an altitude of 3945 feet. It is made up of unconsolidated red basaltic cinders that range in size from $\frac{1}{8}$ inch to 6 inches. The following chemical analysis, based on dry weight, was made by Triplett and Barton, Incorporated, and was furnished by Volcanic Cinder Company.

SiO_2	50.90
Al_2O_3	18.24
Fe_2O_3	7.77
CaO	9.58
MgO	5.73
Na_2O	4.90
K_2O	2.20
TiO_2	1.79
H_2O-	0.22
H_2O+	0.71

This deposit was included in those lands withdrawn from entry (for non-metallic minerals) by Executive Order No. 6206, July 16, 1933, which was issued to protect the water supply of the City of Los Angeles. Effective September 15, 1948, Public Land Order No. 499 modified Order 6206 to permit location and entries for non-metallic minerals only in the lands listed below:

Secs. 18, 19, T. 21 S., R. 38 E., M.D.M.
S$\frac{1}{2}$ sec. 30, T. 22 S., R. 38 E., M.D.M.
N$\frac{1}{2}$ sec. 31, T. 22 S., R. 38 E., M.D.M.

On September 15, 1948, the open portion of sections 30 and 31 was staked completely by C. D. Ray and associates, 1352 East Maple, Glendale, California, Lafayette Morrison and associates, 228 9th Street, Huntington Beach, California, and George Rouff and Henry B. Jarvis, Little Lake, California. To avoid litigation, the land was leased one-half to George Rouff and one-half to Henry B. Jarvis for separate operations.

Redlite Aggregate, Incorporated, Operations. Ownership: A subsidiary of Pioneer Pyrophyllite Company, Chula Vista, California, Ferrar Mathews and Dorothy Benner, 3032 Motor Ave., Los Angeles, California. The land is subleased from George Rouff.

The cinders are mined in an open cut on the flat south of the operation of the Volcanic Cinder Company, and hauled to the screening plant on the west side of U. S. Highway 395, on right-of-way land leased from the Southern Pacific Company. The cinders are dumped over a 4-inch steel rail grizzly into a 150-ton steel bin; oversize material from the grizzly is rejected. The cinders discharge from the bin onto a 24-inch belt conveyor, which passes over a truck loading pit and discharges onto a second conveyor belt. The second conveyor belt is reversible and feeds either to the screens or back into trucks at the loading pit.

The screen is a 4- by 10-foot Symonds 3-deck vibrating screen equipped with $1\frac{1}{2}$-, $\frac{1}{2}$- and $\frac{3}{8}$-inch screens. Oversize materials are either put through a roll crusher or discharged via a belt conveyor to a stockpile of aggregate for monolithic uses. The minus $\frac{3}{8}$-inch material and roll crusher discharge material are fed to a 3- by 10-foot 3-deck screen on top of three steel storage bins, each having a capacity of 75 tons. Sizes stored are $\frac{1}{8}$ inch to pan, $\frac{5}{16}$ to $\frac{1}{8}$ inch, and $\frac{3}{8}$ to $\frac{5}{16}$ inch.

Trucks can be loaded directly beneath the bins and facilities are being prepared to allow loading into railroad cars.

The plant has a discharge capacity of 50 tons per hour for block aggregate, and 75 tons per hour for monolithic aggregate. All equipment is driven by electric motors whose power is being supplied by a 30 kw diesel generating plant.

Volcanic Cinder Company Operations. Ownership: Henry B. Jarvis, P. O. Box 5, Little Lake, California.

The cinders are mined from the south slope of the mountain by open pit methods, using a Caterpillar D-4 tractor with bulldozer to move the unconsolidated cinders to the screening plant. The cinders are pushed over a 3-inch grizzly, and the undersize material is carried by a 16-inch belt conveyor to a $\frac{3}{4}$-inch grizzly. The oversize of both grizzlies is rejected. The undersize material is fed to a 3- by 6-foot vibrating screen (screen size for block aggregate being all minus $\frac{5}{16}$ inch) and a 12- by 26-inch roll crusher in a closed circuit. Minus $\frac{5}{16}$-inch material goes by belt conveyor to the loading bin which has a capacity of 180 tons. Trucks are loaded directly under this dock.

The plant has a discharge capacity of 150 tons per 8-hour day. The material is shipped either by truck or by rail; if by rail, the material is loaded at Little Lake. All equipment is driven by electric motors whose power is supplied by a 30 kw diesel generator.

Sand, Gravel, Crushed Stone

Sand and aggregate materials are available from many parts of Inyo County. The Bishop Engineering and Construction Company is producing them from land near Bishop leased from the City of Los Angeles, Department of Water and Power.

Slate

Black, gray, and red slate has been quarried from a deposit north of Keeler and utilized for roofing granules and flagstone material. In 1947 some material was ground at the Blue Star Mining Company mill at Zurich and used for filler in the manufacture of phonograph records. No slate quarries are operating at the present time.

Sulphur [169]

The largest known deposits of sulphur in California are on the western edge of the Last Chance Range in Inyo County in a series of

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[169] Lynton, Edward D., Sulphur deposits of Inyo County: California Div. Mines Rept. 34, pp. 563-590, 1938.

Tertiary rocks, including gypsum-impregnated limestone breccias, rubbly sandstone, conglomerate, and volcanic rocks. The sulphur was formed by leaching and reduction of the gypsum in the limestone beds and by solfataric action, and it is closely associated with fault zones in all of the deposits.

A conservative estimate places the reserves of ore on the Crater Group of claims at 1,350,000 tons of 40 percent sulphur.[170] In spite of this large reserve, the isolation of the district and the lack of water for milling purposes has discouraged extensive mining. Operations on the principal properties have been described by Tucker and Sampson.[171]

Crater Group. Location: In the Last Chance Range in secs. 33, 34, T. 8 S., R. 39 E., M.D.M. Ownership: 6 claims are owned, seven-eighths by Mrs. Mary M. Bonthrone, 594 San Luis Road, Berkeley, California, and one-eighth by the W. J. Wallace estate, Pomona, California.

This property has been worked by a 32-foot shaft, a 200-foot inclined shaft with levels at 30, 100 and 200 feet, and a large open pit with galleries driven into the sulphur from the pit floor. Also, the extensive exploration work done by the Pacific Sulphur Company during 1929-30 included eight drill holes ranging in depth from 82 to 346 feet.

In 1940 the property was leased to the Pacific Sulphur Company, formerly Sulphur Refiners, Incorporated, and was operated until August 1942. Sulphur was hauled to Zurich and refined in the retort leased from the B and B Sulphur Company (Gulch Group). Several thousand tons of 98.5 percent sulphur was produced and shipped to the Stauffer Chemical Company in Los Angeles. Late in 1941 an explosion destroyed the refinery. Total production of mine-run and refined sulphur is estimated at 12,000 tons.[172]

The property is now leased to R. E. Kitching, Big Pine, who is operating intermittently, producing 45 percent sulphur for agricultural purposes. The sulphur is ground to 40-mesh and either bagged in asphalt-lined bags or bulk shipped in trucks. Two to eight men have been employed.

Talc[173]

Talc mining in eastern California began in the period 1915-18. Since then deposits of Inyo County and north-central San Bernardino County have become one of the Nation's principal sources of high-quality talc. In the last decade the rate of talc production in this area has increased from slightly less than 40,000 to nearly 100,000 tons per year. The present output is valued second only to that of the Gouverneur district in New York.

About 60 talc-bearing regions of commercial interest are known in eastern California; one-half of these are in Inyo County. The talc deposits of the county are of two distinct geologic types, each in a separate geographic belt. One talc-bearing belt, which will be referred to as the Inyo Range talc belt, extends northward from the vicinity of

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[170] Lynton, E. D., op. cit., p. 589.

[171] Tucker, W. B., and Sampson, R. J., Mineral resources of Inyo County: California Div. Mines Rept. 34, pp. 487-492, 1938.

[172] George Pepperdine Foundation, oral communication, 1950.

[173] Much of the descriptive material contained in this section was abstracted from an unpublished report by Ben M. Page. Dr. Page made a study of the steatite-grade talc deposits of California for the U. S. Geological Survey as a strategic mineral investigation during World War II. Additional information was supplied by Lauren A. Wright, Associate Mining Geologist, California Division of Mines.

Darwin to include the Inyo Range, a part of the northern Panamint Range, and the Eureka Valley area. The other belt lies mostly in San Bernardino County, but its northern part is in Inyo County and includes several deposits of commercial significance. This belt extends from the southeastern slope of the Panamint Range eastward to the eastern part of the Kingston Range, a distance of about 70 miles. This will be referred to as the Southern Death Valley-Kingston Range talc belt.

Talc mining in the Inyo Range belt has centered mainly about a group of deposits in the Talc City mine area about six airline miles northwest of Darwin. The Talc City mine itself with a total output of about 250,000 tons has been by far the largest producer. Other properties within a five-mile radius of the Talc City mine are the Alliance, Irish, Frisco, Trinity, East End, Victory, and White Swan mines. These have been worked on a much smaller scale than the Talc City mine.

A group of talc deposits on the southeast slope of the Inyo Range and about 26 airline miles northwest of Darwin is the only Inyo County talc source other than the Talc City mine that has been continuously worked during the last decade. These deposits are generally referred to as the White Mountain mine but include the White Mountain, Florence, and Alberta properties. The deposits of this area are discontinuous bodies exposed for a distance of two miles on the walls of an east-trending canyon. Their combined total output probably does not exceed 50,000 tons.

A third group of talc deposits is in an area on the east flank of the Inyo Range overlooking the northern end of Saline Valley about 20 miles north of the White Mountain mine. In this area three properties, The White Eagle, Willow Creek, and Eleanor mines, have been worked from time to time but have a total output that is probably less than 10,000 tons.

From several hundred to several thousand tons of talc have been obtained from the following other properties in the Inyo Range region: the Lakeview, Lenbeck, and White Star mines, 2½ airline miles north-northwest of Keeler, the Blue Stone mine about ten miles east of Independence, and the Nikolaus mine in the Eureka Valley area.

The part of the Southern Death Valley-Kingston Range talc-bearing belt included in Inyo County contains four talc localities that have yielded more than a few hundred tons. Of these only one property has been worked continuously during the period 1945-1950. This is the Warm Spring deposit in Warm Spring Canyon in the southeastern part of the Panamint Range. The Montgomery and Death Valley deposits, also in the southeastern Panamints, have been worked intermittently, as has the Eclipse mine in the northern Ibex Hills. Unexploited talc deposits in Anvil Canyon in the southeastern part of the Panamint Range, the southern part of the Amargosa Range, and the central part of the Ibex Hills are scheduled to be opened by 1952. Most of the talc output of the Southern Death Valley-Kingston Range belt, however, has been obtained from six properties in San Bernardino County.

Deposits of the Inyo Range Talc-Bearing Belt. Many of the deposits of the Inyo Range belt contain talc of steatite-grade which by definition is suited to the manufacture of high-frequency electrical insulator bodies necessary in many modern electronic instruments. For this use, no adequate substitute for steatite-grade talc is known. Such talc is composed almost entirely of the pure mineral, contains less than 1.5 percent each of calcium oxide and iron oxide, and grinds to particle shapes that are adapted to the extrusion or molding techniques of insulator manufacture.

Before World War II nearly all of the nation's steatite-grade talc was obtained from the Talc City mine. The entry of the United States into the war brought an unprecedented demand for this material and, as the proved reserves at the Talc City mine were small, a serious shortage appeared imminent. Rigid restrictions were placed on the consumption of steatite-grade talc for any except strategic uses, and new sources were sought.

The Talc City mine, however, proved capable of supplying most of the war-time steatite demand, but a significant fraction of the total output was obtained from the White Mountain deposit. During the war years talc of steatite purity was also obtained from most of the previously mentioned deposits of the Inyo Range belt, and from deposits in Nevada, New Mexico, and Montana. Since the end of World War II, relatively large talc reserves have been developed at the Talc City mine, and this property continues to provide most of the domestic output of steatite-grade talc.

Deposits in the southwestern United States that were considered proved or possible sources of steatite-grade talc were studied by members of the U. S. Geological Survey in 1942. The results of these studies have been summarized by Ben M. Page,[174] the geologist in charge of the program.

Most of the talc deposits of the Inyo Range belt have formed as hydrothermal alternations of Paleozoic sediments. The stratigraphy of all of the talc-bearing areas is not yet fully known, but many of the deposits have probably formed in Ordovician sedimentary rocks. The largest of the known talc bodies, those at the Talc City mine, have altered from carbonate sediments; but high-quality talc has altered from silica rocks, chiefly quartzite, as well as from carbonate sediments. At the White Eagle mine a large talc body has formed mostly at the expense of quartz monzonite. The talc deposits are commonly associated with irregular masses of dolomite, which may be hydrothermal alterations of limestone.

The surface exposures of two of the talc bodies at the Talc City mine are each slightly more than 500 feet long and 50 feet in maximum width. Elsewhere in the Inyo Range talc belt, the known deposits are much smaller; most are elongate, but irregular pods are common. Much of the talc has formed along contacts between silica rock and carbonate sediments, or between dolomite and limestone. Other talc bodies are entirely within one type of rock and represent alteration along fractures or shear zones.

The talc ranges in color from dark gray through various shades of lighter gray and green to nearly white. Most of the light-colored varieties have altered from quartzite and light-colored carbonate sediments. The darker colors may have been inherited from dark-colored carbonate sediments. In most of the deposits of the Inyo Range belt the talc is very fine-grained, compact, and blocky, but a marked schistosity is not uncommon. Disseminated limonite cubes, pseudomorphous after pyrite, are the most common impurity. Most of the carbonate material in the talc bodies is thin fracture-fillings.

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[174] Page, B. M., Some California talc deposits of steatite-grade: in preparation, U. S. Geological Survey.

Alberta Mine. Location: On the east slope of the Inyo Range near the southern end of Saline Valley in T. 16 S., R. 38 E., M.D.M. (projected). Ownership: William Bonham, Lone Pine, California.

A talc body as much as 20 feet wide and of undetermined length occurs in crystalline dolomite. The talc is high quality and of steatite-grade. Workings consist of an inclined shaft and related drifts and stopes.

The property is active.

Alliance Mine. Location: Near the southern end of the Inyo Range in secs. 20, 29, 30, T. 18 S., R. 40 E., M.D.M., about 6½ airline miles northwest of Darwin. Ownership: Edith Lockhart and George Koest, Box 75, Darwin, California, own 9 unpatented claims.

This deposit of steatite-grade talc has been described by Page[175] as resulting from the shearing and hydrothermal alteration of a quartzite-like silica rock which forms ''islands'' in massive dolomite. This silica rock has an obscure origin, but it also may be a hydrothermal product.

The mine is developed by a 100-foot shaft with several hundred feet of drifting, an 85-foot shaft with about 100 feet of drifts, a 30-foot shaft and a small glory hole 30 feet deep.

Several operators have produced talc from the Alliance mine over a period of eight or nine years. Page[176] reports a total production of between 5000 and 10,000 tons of talc. Mr. Koest orally reported a total production of 15,000 tons.

Equipment on the property includes a hoist powered by a Star engine and a Sullivan 110 cubic foot air compressor.

The mine is idle.

Blue Star Talc Mine. Location: On the east slope of the Inyo Mountains, on the south side of Big Pine Creek in sec. 36, T. 9 S., R. 32 E., M.D.M., about 8½ airline miles southeast of Pig Pine. Ownership: Blue Star Mines, Ltd., John Spindler, president, 667 S. Anderson St., Los Angeles 23, California, owns 9 unpatented claims.

Irregular masses of talc are in serpentine or in the contact zone of serpentine with crystalline limestone.[177] The masses have been small; one of the largest was 15 feet wide, 70 feet long and 45 feet high.

The workings consist of an adit driven 200 feet in a southeasterly direction and a southwest-trending drift started 140 feet from the adit portal. The talc was mined from this drift. Adjacent to these workings is a limestone quarry.

Talc and limestone were lowered over a 1200-foot gravity tram to a compartmented bin. Trucks loading from this bin hauled the talc and limestone to the grinding plant at Zurich, a station on the railroad two miles east of Big Pine. Talc mining operations were stopped in 1945 and the limestone quarrying was stopped in 1948. The mine is idle, but the mill is processing talc from other mines and from the Blue Star Mines, Ltd., in Nevada.

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[175] Page, Ben M., Some California talc deposits of steatite-grade: Mining and Industrial News, vol. 16, no. 1, p. 12, 1948.

[176] Page, Ben M., op. cit., p. 12, 1948.

[177] Tucker, W. B., and Sampson, R. J., op. cit., p. 492, 1938.

In the mill, crude ore is crushed in an 11- by 18-inch jaw crusher and elevated to a bin. Crushed ore is fed from this bin to a Raymond mill and cyclone dust collector, with a 48-inch fan, in closed circuit. Standard sizes of 150, 200 and 325 mesh talc are bagged by a Bates bagging machine. Fines from the cyclone dust collector are bagged. These fines are all minus 30 microns in size. The mill has a capacity of 10 to 15 tons per 8-hour shift depending on the fineness of grinding.

Nine men are employed.

Blue Stone Mine. Location: 10 miles east-northeast of Independence on the west slope of the Inyo Range, reached by the Mazourka Canyon Road. Ownership: Walter Sorenson, Lone Pine, California. (1942).

The deposit is in a section of Paleozoic sedimentary rocks which dips steeply westward. Limestone predominates near the mine, but the talc has formed above a quartzite layer, 20 to 60 feet thick. The talc body, which is now largely worked out, was a lens which in plan was about 40 feet long and 10 feet in maximum width. It extended down-dip for about 40 feet. It has formed as a replacement of the quartzite. The talc is mottled gray, blocky, and is probably of steatite-grade.

Bob Cat Claims (East End Mine). Location: About 6 miles northwest of Darwin near the south end of the Inyo Range in sec. 28, T. 18 S., R. 40 E., M.D.M.

Ownership: R. H. Bagley (1942).

This property has been generally known as the East End Mine and was relocated as part of the Bob Cat claims.

The principal talc body, which is mostly mined out, was a lens on a contact between massive dolomite and platy limestone. The talc is pale green, fine-grained, and crudely schistose. Most of the talc has been removed from a stope between the 30-foot level and the bottom of a 60-foot inclined shaft. The stope extends for a lateral distance of more than 100 feet. A 35-foot winze, sunk from the 60-foot level, is joined at the bottom by a 70-foot drift. Much of the talc body is from 5 to 15 feet wide, but it narrows to an average thickness of one foot in the lowest levels.

Eleanor Mine. Location: About 27 airline miles north-northwest of Keeler, California on the east slope of the Inyo Range in T. 13 S., R. 37 E. Ownership: G. P. Rogers and Frank Henderson, Lone Pine, California.

Talc, probably of steatite grade, in a zone 100 or more feet in length and as much as 15 feet thick is in an area underlain principally by dolomite and dolomitic marble.

The property is idle.

Frisco Mine. Location: Southwest of the Talc City Mine in sec. 36, T. 18 S., R. 39 E., M.D.M. Ownership: School land owned by the State of California. SE$\frac{1}{4}$ NE$\frac{1}{4}$ sec. 36 leased to Sierra Talc and Clay Company, 5509 Randolph St., Los Angeles, California.

The area, like that of the Talc City mine, is underlain principally by massive dolomite that contains irregular masses of limestone and subordinate amounts of a silica rock that is probably quartzite. The Frisco mine area also contains felsic dikes that are commonly several tens of feet in width, and that have been almost completely chloritized. The chlorite is marketed under the trade name ''Sierralite'' for use in cordierite ceramic bodies, and has been mined in much greater quantity than the talc.

The talc, in a single zone which is about ten feet wide, is discontinuously exposed on the surface for a distance of 100 feet. Most, if not all of the talc has altered from a silica rock layer and is apparently of steatite grade.

The talc body has been worked by a 100-foot, 60° inclined shaft and 1200 feet of drifts and crosscuts. It has been mined only intermittently. The chlorite has been mined by open pit methods, using a Universal $\frac{3}{8}$-yard, gasoline-driven shovel on crawler tracks.

Irish Lease (*Quackenbush Lease*). Location: Near the southern end of the Inyo Range in the SW$\frac{1}{4}$ T. 18 S., R. 40 E., M.D.M., about 6 airline miles northwest of Darwin. It adjoins the Alliance Mine on the south. Ownership: Mrs. Eva Irish, Los Angeles (1942). Leased to W. J. Quackenbush, 1942.

Talc, in irregularly distributed masses is in a contact zone between the silica rock and slate. The zone is exposed for a distance of about 250 feet and apparently does not exceed six feet in thickness. The workings consist of three deep pits and a 35-foot shaft to which a short drift is joined. Production from the mine amounted to 2000 tons of ore.

The property is idle.

Lakeview Mine. Location: $2\frac{1}{2}$ miles north-northwest of Keeler on the west slope of the Inyo Range. Ownership: A. C. and Raymond Palmer, Lone Pine, California (1942).

Talc has been produced from two lenses of ore, one of which is at a contact between quartzite and stratified carbonate rock and the other in a sliver of carbonate rock enclosed in a diabase dike. Work done includes a 50-foot vertical shaft, a short drift from the bottom and two stopes, one in each of the orebodies. Production is estimated at 2000 tons of ore.

The mine is idle.

Lakeview Talc Deposit. Location: 8 miles northwest of Keeler in sec. 4?, T. 16 S., R. 37 E., M.D.M. (projected). Ownership: 1 claim is owned by H. Taylor and H. Stewart of Big Pine, California.

Talc, 7 to 10 feet thick, occurs as a replacement deposit in dolomite beds which dip steeply to the northeast along the southwest flank of the Inyo Mountains. A portion of the talc is white and free from impurities, but some is stained.

A 75-foot tunnel was driven in the talc; some stoping was done above the tunnel level. A winze sunk near the portal exposed seven feet of talc at a depth of 40 feet.

Talc was shipped 52 miles by truck to the Blue Star Mines, Ltd. grinding plant at Zurich.

The mine is idle.

Nikolaus Talc Mine (*Lane and Nikolaus*). Location: On the west side of Eureka Valley, approximately in sec. 23, T. 8 S., R. 37 E., M.D.M. Ownership: 2 claims are owned by James Nikolaus, Big Pine, California.

This property has been a large producer of steatite talc. No total production figures are available, but in 1945, 2000 tons was produced and shipped to the Blue Star Mining Company's grinding plant at Zurich. Recent production has been at the rate of 20 to 25 tons per day, and talc is shipped to both Sierra Talc and Clay Company at Keeler and to the Blue Star plant at Zurich.

From 2 to 5 men are employed.

Silver Dollar. Location: Near the southern end of the Inyo Range in secs. 28, 29, T. 18 S., R. 40 E. about 6 airline miles northwest of Darwin. Ownership: Edith Lockhart and George Koest, Box 75, Darwin, California own 6 unpatented claims.

Irregular bodies of talc in dolomite have been worked on one of the claims by a steeply-inclined shaft 175 feet deep from which there are several hundred feet of workings.

During 1947 and 1948 the claim was leased by Stewart Anderson, and Mr. Koest orally reported that $9000 worth of talc was shipped during 1947.

Two men were employed.

Talc City Mine (*Inyo Talc Company Mine, Simonds*). Location: Near the south end of the Inyo Range in secs. 28, 29, 32, 33, T. 18 S., R. 40 E., M.D.M. about 5½ airline miles northwest of Darwin. Ownership: 21 claims are owned by the Sierra Talc and Clay Company, 5509 Randolph St., Los Angeles, California.

This property was first known as the Simonds mine and was owned by the Groah Mineral Company of San Francisco before 1915. During the period 1915-17, the mine was operated by the California Talc Company. In 1917 it was purchased by the Inyo Talc Company which became the Sierra Talc Company in 1922.

Much of the mine's early output was used in the manufacture of insulating cores for Hotpoint stoves. The first cores were made by turning and firing block talc. This process proved wasteful and was later supplanted by methods in which ground talc is molded or extruded. In the mid-nineteen-thirties the value of talc insulators in high frequency electrical equipment was recognized. Most of the mine's output during the past decade has been used in the manufacture of such insulators. The talc is also used by the paper, rubber, and cosmetic industries. In 1950 the mine had produced a total of about 250,000 tons.

All of the talc bodies of the Talc City property are contained in an irregular mass of dolomite many hundreds of feet in maximum dimension. Limestone surrounds the mass and is included in it as islands. Irregular masses of silica rock are also included in the dolomite. Much of the talc has formed along contacts between dolomite and limestone, but dolomite commonly forms both walls.

The Talc City mine area contains numerous talc bodies, but most of the mine's output has been obtained from a single body (the East body) of which the surface exposures are about 500 feet long and 50 feet in maximum width. This body strikes north-northwest and dips about 70° west. It has been worked down dip for a slope distance of about 415 feet. The surface exposure of the West body, which parallels the East body about 200 feet to the west, is of comparable size, but has not been encountered at a depth greater than 100 feet. Appreciable quantities of talc have also been obtained from the Evening Star body, an irregular mass several hundred feet north of the northern tip of the East body.

The main is the 415-foot inclined Morning Star shaft, which has four working levels, A, B, C, and D. Two other levels, E and F, are partly caved and have not been fully reopened. The current production is from square-set stopes on C-level. The talc is transferred to B-level, the main haulage way, and trammed to the shaft. The Evening Star talc body is being mined from a glory hole connected to B-level by a winze.

Mine-run material is passed over a $\frac{3}{4}$-inch slot screen. The undersize material is sold as ''screenings.'' The talc is hand-sorted from the oversize on a picking belt and transferred to truck-loading bins. The average crew is about 24.

Talc from the Talc City mine and other mines is hauled to the mill at Keeler and placed in flat open-storage area. Crude ore is picked up by a Hough loader and fed directly into a Wheeling jaw crusher, crushed to $\frac{1}{2}$-inch and carried by bucket elevator to an 18-ton crushed-ore bin. The crushed ore is gravity-fed to a Raymond 4-roll grinding mill in closed circuit with a Raymond Whizzer separator, with a Reeves variable-speed drive control, and a cyclone collector. A number of sizes of ground talc can be produced.

To produce talc of less than 10 microns in size, the material is fed from a cyclone collector in the 4-roll grinding mill circuit into a Raymond high-speed, vertical mill in closed circuit with a Dracco dust collector.

Finished talc is packed in 50-pound sacks by a Bates double-spout packer from a 12-ton bin. All units are electrically driven. The plant capacity per 8 hours ranges from 30 tons when grinding to 200-mesh to 25 tons when grinding to 425-mesh. Three shifts are normally worked, with 11 men employed under M. B. Miller, mill superintendent.

Trinity Mine (Pacific Coast Talc Mine). Location: Southwest of the Talc City Mine in secs. 25, 36, T. 18 S., R. 39 E., M.D.M. Ownership: 9 claims in sec. 25 are owned by Sierra Talc and Clay Company, 5509 Randolph Street, Los Angeles, California. In addition, the NE$\frac{1}{4}$ NE$\frac{1}{4}$ sec. 36 is subleased from the Mt. Whitney Talc Company, which holds a lease from the California State Lands Commission.

Bodies of talc have replaced massive dolomite along fractures. Silica rock is exposed in the area, but is not associated with the talc. The talc is pale green; it is similar to the material in the Talc City deposits, and is of proved steatite grade.

The workings consist of a gently inclined shaft 120 feet deep and a vertical shaft about 140 feet deep. From these, numerous drifts, crosscuts, and stopes have been run in which only small amounts of talc remain.

The total output of this mine is not known with certainty, but it is reported to have been a large producer in the nineteen-twenties and thirties. The mine was idle during the nineteen-forties, but was reopened early in 1950.

Victory Mine. Location: 7$\frac{1}{2}$ miles northwest of Darwin and 1$\frac{1}{2}$ miles northwest of the Talc City Mine at the south end of the Inyo Range. Ownership: Edith Lockhart and George Koest, Box 75, Darwin, California (1942).

The talc, which is similar to material from the other properties of the Talc City Mine area, is in a steeply-dipping zone that is mostly from three to five feet wide, and is exposed for a distance of about 50 feet. A 25-foot shaft is on the talc zone; and a 170-foot adit was driven from a hill slope to a point 50 feet below the shaft collar but did not intersect a downward extension of the zone.

The property, now idle, was operated for a short period during World War II and has produced a relatively small tonnage.

Viking Talc Mine. Location: Near the southern end of the Inyo Range in secs. 23, 24, T. 18 S., R. 39 E., M.D.M. (projected) about 9 airline miles northwest of Darwin, California. Ownership: Edith Lockhart and George Koest, Box 75, Darwin, California, own 14 claims.

Talc, some of which is of steatite grade, is in comparatively small masses, associated with steeply dipping siliceous bodies in massive dolomite. The property has a 100-foot shaft and a 60-foot shaft, each with about 100 feet of drifts. The mine has been operated by lessees and the total production, as orally reported by Mrs. Lockhart, is about 2000 tons.

Equipment includes a Sullivan compressor, 110 cubic feet per minute capacity, and a hoist powered by a LeRoi gasoline engine.

The property is idle.

White Eagle Mine. Location: About 25 airline miles north-northwest of Keeler or 137 miles by road from Keeler via Big Pine, in the NE¼ T. 13 S., R. 37 E., M.D.M. (projected), on the east slope of the Inyo Range. Ownership: Sierra Talc and Clay Company, 5509 Randolph Street, Los Angeles, California. Under lease to Wright Huntley of Bishop, California.

Most of the talc in the mine area is in a large, irregular body with an outcrop plan about 500 feet long and 160 feet in maximum width. This body has formed near the contact of a section of Paleozoic sedimentary rocks with the large quartz monzonite mass that occupies much of the central part of the Inyo Range. The talc has formed mostly at the expense of quartz monzonite, but both dolomite and quartzite in the sedimentary section have also altered to talc. Gray talc has formed from dolomite, white talc from quartzite, and light green talc from quartz monzonite. Each type is fine-grained, compact, and resembles talc found elsewhere in the Inyo Range.

Three short adits have been driven into the main body, but most of the talc has been mined by open cut benching. Further benching, however, will involve removal of large quantities of overburden, a slide of which now covers much of the quarry face. The talc is transported to the valley floor by means of a 2000-foot jig-back aerial tram. Production has been between 3000 and 4000 tons of talc.

The property is idle.

White Mountain Claims (Florence Mine). Location: On the east flank of the Inyo Range near the southern end of Saline Valley about 8 airline miles northeast of Keeler, in T. 16 S., R. 38 E., M.D.M. (projected). Ownership: 6 claims are owned by Sierra Talc and Clay Company, 5509 Randolph Street, Los Angeles, California. Leased by William Bonham, Lone Pine, California.

This property is one mile east of the White Mountain Mine and in the same canyon. The rock units, like those of the White Mountain mine, are principally limestone and dolomite with subordinate quartzite. Both the carbonate rocks and the quartzite have been altered to talc in numerous places. The talc is medium gray to light green and very blocky. It appears to have formed principally along fractures. In only a few places is the talc in deposits large enough to be of commercial interest. The surface exposure of the largest of the area's known talc deposits is about 200 feet long and from five to ten feet wide.

The property is exploited by numerous open cuts, adits, and shallow shafts distributed through an area about one-half mile long and one-tenth mile wide. One 80-foot adit driven southeastward from the canyon wall intersects the 200-foot talc zone described above, at a depth of about 55 feet.

The total production from 1938 to 1948 was about 7000 to 8000 tons of talc. The property is still in operation.

White Mountain Mine. Location: About 8 miles northeast of Keeler, on the east slope of the Inyo Range, in T. 16 S., R. 38 E., M.D.M. (projected). Ownership: 3 patented claims are owned by Roy C. Troeger, 4600 Encino Avenue, Encino, California. Under lease to William Bonham, Lone Pine, California since 1938.

The White Mountain mine area is underlain principally by Paleozoic dolomite and limestone. Within these carbonate rocks are layers and irregular masses of siliceous rock of which most, if not all, is quartzite. The sediments have been invaded by numerous rhyolite dikes that commonly are partly to thoroughly chloritized. Much of the bedrock is hidden beneath mantle. The area has a very complex structure, including several northwest-trending faults.

Talc bodies have formed as alterations of both the carbonate and siliceous rocks. Many have formed along contacts between various rock types, others have formed along faults and fractures within individual lithologic units. Angular blocks of talc also are concentrated at the base of the mantle. Such concentrations have been worked in several places by shallow adits and trenches.

The White Mountain mine workings are confined to an area of approximately 30 acres, and consist of about 40 adits and numerous trenches and bulldozer cuts. Because none of the known White Mountain talc bodies are as large as the larger bodies at the Talc City mine, the White Mountain workings are comparatively shallow. Most of the adits are disconnected and none exceed a few hundred feet in length.

The White Mountain mine together with the neighboring Florence and Alberta mines have yielded a combined production to date of 20,000 to 25,000 tons of talc.

The property is active.

White Swan Mine. Location: At the south end of the Inyo Range in sec. 23, T. 18 S., R. 39 E., M.D.M. (projected) about 9½ airline miles northwest of Darwin. Ownership: 5 unpatented claims are owned by Edna M. Towers, 316 W. Imperial Highway, Los Angeles. Leased to C. W. James, Lone Pine, California.

The White Swan mine has worked lenses of talc in massive dolomite. These lenses have formed mostly along fractures. Silica rock is exposed in the area, but is not associated with the talc. The largest talc lens is about 125 feet long, but does not exceed 5 feet in thickness.

The workings consist of two shafts each less than 30 feet deep, two adits each less than 50 feet long, and a 700-foot adit driven mostly in barren dolomite. The total production is less than 1000 tons, but the talc probably was of steatite purity.

The property is idle.

Willow Creek Mine. Location: About 26 airline miles north-northwest of Keeler on the east slope of the Inyo Range and on the south side of Willow Creek Canyon in the NE¼ T. 13 S., R. 37 E., M.D.M. (projected). Ownership: Emil Carlson (1942).

The talc is apparently on the edge of a pendant of limestone in quartz monzonite. The entire mine area, however, seems to be underlain by a landside, and the mine workings are in highly fractured rock. The talc body is poorly exposed but has a maximum thickness of about 20 feet. It thins markedly in both directions along strike. The talc resembles the steatite mined elsewhere in the Inyo Range and probably is of steatite purity.

Mining was largely a glory-hole operation. The talc was trammed to the surface along two adits, one below the other. Much timbering was required in the lower adit. The total amount of talc produced was about 1000 tons, obtained mostly in the period 1941-42.

The property is idle.

Deposits of the Southern Death Valley-Kingston Range Talc-Bearing Belt. The talc deposits of the Southern Death Valley-Kingston Range talc-bearing belt are confined to the late pre-Cambrian Crystal Spring formation. Exposures of this formation are not known outside of the general area of the belt. The formation averages about 4000 feet in thickness and is divisible into three lithologic units: a lower unit composed of feldspathic quartzite, shale, and argillite, a middle unit composed mainly of massive dolomite and limestone beds, and an upper unit of variable and alternating beds of quartzite, shale, and carbonate sediments.

The carbonate sediments that comprise the middle unit have been extensively invaded by diabase, principally as sills. An especially persistent sill occupies a position at or near the contact between the lower and middle units. Most of the talc deposits of commercial interest have formed as alterations of carbonate sediments along the borders of this sill. The others are also altered carbonate sediments, but most are separated from the sill by non-carbonate strata.

The deposits of the Southern Death Valley-Kingston Range belt, unlike those of the Inyo Range area, are markedly foliated, contain carbonate material as a prominent constituent, and are commonly highly tremolitic. Their constituent mineral grains are ordinarily much coarser and less nearly equant than the grains of the steatite deposits described above. Unlike the steatite-grade talcs, these foliated, carbonate-bearing talcs are unsuited to insulator manufacture, but they are used principally as wall-tile ingredients and as paint extenders.

Death Valley Talc Mine. Location: On the west side of Death Valley in the Panamint Mountains in Galena Canyon approximately in T. 22 S., R. 47 E., M.D.M. (projected). Ownership: 10 claims and a millsite are owned by the Death Valley Talc Company, S. E. Chiapella, vice president, 1625 Las Palmas Avenue, Hollywood 26, California.

A talc zone 4 to 30 feet thick occurs along the contact between dolomitic limestone and an underlying diabase sill. Some thin bands of limestone are within the talc zone. The zone has a strike of N. 20°-40° E., a dip of 20° SE., and it crops out for a distance of 6000 feet.

The mine has two short adits on the White Chief claim which crosscut into the talc and then follow the talc on an inclination of 20 degrees; one is 175 feet long, the other 180 feet. Underground workings from these inclines, including a 300-foot drift, total over 600 feet. On the White Eagle claim to the northeast, a drift adit has been driven about 100 feet and has two short crosscuts. As exposed in the incline workings, the talc is from 4 to 15 feet thick, with most of the workings in at least 6 feet of talc. The character of the talc varies from a soft, crumbly talc in the incline workings to a harder, massive talc in the workings to the northeast.

The property was last worked during the period 1939 to 1943 by the Pomona Tile Company which produced 8900 tons. Total production is estimated at 25,000 tons, most of which was used by the cosmetics industry.[178] The mill which was on the property [179] is dismantled.

The property is idle.

Donna Loy Group (Paulson). Location: At the southern end of the Nopah Range approximately in sec. 26, T. 20 N., R. 8 E., S.B.M. (projected). Ownership: 4 claims are owned by L. D. Fairbanks, Daggett, California.

The mine is in a talcose zone exposed on the southwest slope of a small spur. The zone, an alteration of dolomite of the Crystal Spring formation, is poorly exposed at the surface but is probably at least 500 feet long. At the mine workings the zone ranges from 6 to about 15 feet in width. The deposit and the enclosing sediments dip northward at an angle of about 80 degrees, and are in fault contact with early pre-Cambrian schist. The trace of the fault is about 20 feet down-slope from the deposit at the mine workings. The fault dips moderately eastward and truncates the talc zone at a depth of about 35 feet. The talc is white to light-gray, schistose and friable. Much of it is finely powdered, probably because of fault movement.

A 36-foot shaft is inclined northward at an 80 degree angle. The shaft was sunk on the talc body to the point at which the talc was truncated by the schist. A 22-foot drift follows the talc zone eastward to a point where the zone is but 6 feet wide.

The property, now idle, was first worked in 1948 and has had a small output.

Eclipse Mine (Kennedy Eclipse). Location: On the east slope of the Amargosa Range in sec. 7, T. 20 N. R. 6 E., S.B.M. (projected) about 12 miles southwest of Shoshone. Ownership: 4 patented claims, the Eclipse Nos. 1 and 2 and the Comet Nos. 1 and 2, are owned by A. E. Nicholls, 1400 E. Olympic Blvd., Los Angeles and leased to the Kennedy Minerals Company, 2550 E. Olympic Blvd., Los Angeles.

The talc deposits at the Eclipse mine are typical of many in the region in that they have formed adjacent to the upper margin of a diabase sill and represent an alteration of the lowermost carbonate sediments of the Crystal Spring formation.

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[178] Sutherland, Clark, private report.

[179] Tucker, W. B., and Sampson, R. J., op. cit., p. 493, 1938.

The talc bed mined on the two Eclipse claims, is 12 to 16 feet thick, strikes N. 45°-50° E., and dips 30° SE. In the older workings on the Eclipse No. 1 claim the talc was cut by a fault striking N. 79° E. and dipping 80° N.

The Eclipse No. 1 claim was worked by three adit levels at intervals of 30 and 50 feet. The lowest level was driven to intersect the faulted talc vein and has about 700 feet of drifts and crosscuts. The two upper levels were stoped extensively and are now caved. The Kennedy Minerals Company obtained a lease in 1940 and mined about 12,000 tons of talc from these workings. It is estimated that the total production was about 50,000 tons of talc.[180]

Recent work by Kennedy Minerals has been on the Eclipse No. 2 claim. A cross cut adit has been driven 175 feet and a 70-foot raise intersects the talc which has flattened in dip. A crosscut was driven to the surface again from the top of the raise and drifting has been started from the raise. About 500 tons of talc has been produced from these workings.

The property has been worked intermittently on a contract basis.

Markley Deposits. Location: In the Ibex Hills, at the southeastern end of the Amargosa Range, approximately in sec. 35, T. 21 N., R. 5 E., S.B.M. and secs. 2, 11, T. 30 N., R. 5 E., S.B.M. (projected). Ownership: 19 claims are owned by the Sierra Talc and Clay Company, 5509 Randolph Street, Los Angeles, California.

The Markley talc deposits, like numerous others elsewhere in the region, are alterations of the lowermost carbonate beds of the Crystal Spring formation and have formed along the upper margin of a diabase sill.

The talc zone is poorly exposed along a two-mile belt near the crest of the central part of the Ibex Hills and is covered in places with thick accumulations of talus. Talc of apparent commercial grade is exposed in several places; the largest exposure may be as much as 30 feet wide and 500 feet long. Some exposures of the upper margin of the sill, however, show relatively little alteration and indicate that the potential commercial deposits probably do not continue indefinitely beneath talus-covered slopes. The talc is characteristically foliated, coarse-grained and very friable.

These deposits have been worked by a few cuts and shallow adits only and in 1950 had not been worked commercially. An access road was being built, however, and the opening of the deposits within a year or two is anticipated.

Montgomery Talc Mine. Location: At the upper end of Warm Spring Canyon approximately in T. 23 S., R. 46 E., M.D.M. (projected). Ownership: 12 claims are owned by H. P. Gower and associates, 510 W. 6th Street, Los Angeles, California, and leased by Sierra Talc and Clay Company, 5509 Randolph Street, Los Angeles, California.

The geology of the Montgomery mine is similar to that of the other Warm Spring talc deposits. Two horizons of talc underlying a dolomitic limestone strike N. 75°-80° W. and dip 18° south. The upper deposit has been worked by a 100-foot incline and a 100-foot crosscut from the bottom of the incline. Drifts and raises have been driven from the crosscut. The lower deposit has been exploited by 500 feet of drift and a 75-foot inclined winze. Some stoping has been done from the bottom of the winze. Total production has been around 3000 tons.

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[180] Kennedy, J. J., oral report.

The property is inactive except for assessment work, due to the difficult haulage problem.

Owlshead Mountain Deposits. A talcose alteration zone occurs in a section of the Crystal Spring formation at the northern end of the Owlshead Mountains. The zone is exposed for a distance of about one mile. Most of the zone is about 1500 feet above the mountain base and can be reached only by walking over relatively steep slopes. The construction of a road to these deposits would be very expensive. The deposits have been exploited by a few shallow cuts only and have had no commercial output.

In this area the Crystal Spring formation dips moderately to steeply northeastward, and is composed mostly of quartzite, and shale (the lower units of the formation) and diabase (the sill mentioned in the discussion of the Markley deposits). The talc alteration is irregular in both distribution and intensity, but is confined to a zone about 100 feet wide beneath the diabase sill.

The largest of the alteration bodies have surface exposures as much as 30 feet wide and 400 feet long, but the concentrations of potentially commercial talc within such bodies appear to be much smaller.

Warm Spring Talc Deposit. Location: 35 airline miles west of Shoshone and 2 miles east of Warm Spring in Warm Spring Canyon, Panamint Range; secs. 4 and 5?, T. 21 N., R. 1 E., S.B.M. (projected). Ownership: 11 unpatented claims are owned by Miss Louise Grantham and associates, 809 E. 6th Street, Ontario, California. 2 claims, Warm Spring No. 5 and Higrade, are under lease to Kennedy Minerals Company, Incorporated, 2550 E. Olympic Boulevard, Los Angeles, California.

The Warm Spring Canyon deposits are discontinuously exposed along a two-mile belt low on the south wall of Warm Spring Canyon in the southeastern part of the Panamint Range. All the belt lies east of Warm Spring Camp, which is about 2½ miles west of the canyon's mouth.

The talc deposits of the Warm Spring Canyon area, like all of the others in the southern Death Valley-Kingston Range region, are in the Crystal Spring formation of pre-Cambrian age, and have formed at or near a contact between a diabase sill and lowermost carbonate stratum of the formation. Strata as far as 100 feet above the sill have been partly altered to talc, but the most complete alteration is confined to a zone adjacent to the diabase. This is the zone that is being worked on the two claims at the eastern end of the belt. In several places, however, the alteration has not produced commercial talc, and in other places the rocks that overlie the diabase are hidden beneath talus. Nevertheless the reserves of commercial talc in the Warm Spring belt appear to be among the largest in the state. In the area of the active workings, the zone of marketable talc consistently averages more than 13 feet thick, and has been worked as much as 500 feet along the strike with no marked variations in thickness or grade. Only a small part of the zone has been exploited.

The zone consists predominantly of talc with subordinate carbonate material and little or no tremolite. The lower one-third to one-half of the zone is consistently fine-grained and thinly laminated but non-schistose. The upper part is coarser-grained and schistose.

Both Warm Spring Number 5 claim (Kennedy Minerals Company, Incorporated) and Big Talc claim (Louise Grantham) have been worked in a similar manner. Adits are driven along the strike of the talc zone and connected by low angle (about 20°) raises. From these initial workings the talc is mined by a modified room-and-pillar system, utilizing compressed air slushers to move and load the broken material. At times, one slusher is set in a central position at the intersection of an adit and raise to move material from the adit as well as from the raise. The mechanization and mining methods have resulted in a high-tonnage-per-man-hour ratio. The lower talc zone being worked has required little or no timbering, but an adit driven above this zone in the ''middle bed'' was abandoned because of the heavy roof and resultant caving.

Output from the deposit to January, 1950 was 32,700 tons of talc. The material is hauled by truck to Dunn, a siding on the Union Pacific Railroad 30 miles southwest of Baker, California.

Miscellaneous Minerals

Beryl, graphite, iceland spar (optical calcite), and wollastonite are listed in the tabulated index of nonmetallic mineral deposits in this report. Exposures of beryl on the west flank of the Inyo Mountains, of graphitic schist in Telephone Canyon in the Panamint Range, and of wollastonite in Warm Spring Canyon, are unexploited. The deposit of iceland spar three miles north-northwest of Darwin has been worked, but the material failed to meet the requirements for optical purposes.

Grinding Plants

Four plants process industrial minerals in Inyo County. The Blue Star Mines, Limited, plant at Zurich, which processes, several minerals, is described elsewhere in this report. The Keeler plant of Sierra Talc and Clay Company is described in the Talc City Mine summary.

Huntley Industrial Minerals, Incorporated Grinding Plant. Location: Laws, California. Ownership: Huntley Industrial Minerals, Inc., W. H. Huntley, president, Box 305, Bishop, Calif.

Pyrophyllite, talc, clay and feldspar are among the materials produced by the company from Inyo and Mono County deposits and processed at the Laws plant.

From the receiving ore bin, material is fed by belt conveyor to a 40-horsepower, 25-ton hammer mill. The minus $\frac{3}{4}$-inch product is then elevated by a bucket conveyor and discharged either directly to a Raymond, 5-roll, high-side mill or if necessary, first run through a rotary drier. The Raymond mill, operating in conjunction with a double-cone air classifier produces a 95 to 97 percent minus 325-mesh product. Bagged material is packed by a St. Regis 2-spout automatic packer. Dust is controlled by a suction system and bag house. Increased capacity and greater flexibility of operations will be provided by installation of an additional double-cone air classifier, bag house and a new mill unit. Plans for the mill are complete and equipment purchased. The new unit will occupy the former shop building of the U. S. Vanadium Corporation in Laws. 10 men are employed.

Pacific Coast Pumice Company Grinding Plant. Location: Laws, California. Ownership: Pacific Coast Pumice Company, C. W. Churchill, president and manager, P. O. Box 656, Bishop, California.

A deposit of pumice in Mono County just north of the Inyo-Mono County boundary was formerly processed at a plant on the property. A new plant at Laws, completed in 1948, is designed to handle the minus 10-mesh pumice from the scalping plant at the deposit. The equipment includes a roll crusher and a series of screens which will produce 14 different sizes of pumice.

Salines

Salines have been economically important to Inyo County in the past and constitute an enormous reserve of potential mineral wealth. The present production is small, particularly if compared with the years when the Death Valley borax deposits and the brines of Owens Lake were vigorously exploited. In the 9-year period, 1907-1915, 8 million dollars worth of borax was produced; in the 6-year period 1926-1931, soda output averaged 1¼ million dollars annually. Complete production figures of all saline products are not available, as for the past several years annual statistics have been combined to conceal individual output.

In 1949 activity was confined to the production of borate minerals from a deposit near Shoshone and of borax and soda ash from Owens Lake.

Borax[181]

Borax was first produced in Inyo County from crustal concentrations of the mineral in the playas of Death Valley, Saline Valley, and the Resting Springs district.[182] The important deposits, however, are those in the foothills of the Black Mountains in the Ryan area. Colemanite and ulexite occur here in a series of folded and faulted Tertiary sediments, within borate-bearing beds as much as 100 feet thick. Similar deposits are found in the Amargosa Valley near Shoshone.

Inyo County became the largest borax producer and remained so until the exploitation in 1926 of the Kramer deposits in Kern County. The newly discovered sodium borate mineral, kernite, proved more amenable to treatment than the calcium borate mineral, colemanite, and exploitation of the rich Inyo County deposits ceased in 1928.

Gypsum[183]

Gypsum deposits of Teritary age are found in Copper Canyon and Furnace Creek in the Death Valley region, in the Resting Springs district northeast of Tecopa, and near China Ranch. The China Ranch deposit, worked in the period 1914-18 by the Acme Cement and Plaster Company, consists of individual gypsum beds, 6 inches to 3 feet thick in a brown clay shale. The total thickness of the beds is as much as 20 feet.[184]

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[181] Tucker, W. Burling, op. cit., pp. 274-277, 1921.
Tucker, W. Burling, op. cit., pp. 524-526, 1926.
Tucker, W. B., and Sampson, R. J., op. cit., p. 496, 1938.
Waring, Clarence A., and Huguenin, Emile, op. cit., pp. 62-69, 1919.

[182] Bailey, Gilbert E., Saline deposits of California: California Min. Bur. Rept. 24, pp. 36-40, 1902.

[183] Tucker, W. Burling, op. cit., p. 282, 1921.
Tucker, W. Burling, op. cit., p. 526, 1926.
Tucker, W. B., and Sampson, R. J., op. cit., p. 496, 1938.
Waring, Clarence A, and Huguenin, Emile, op. cit., pp. 85-87.

[184] VerPlanck, William E., Jr., Mineral commodities of California: California Div. Mines Bull. 156, p. 226, 1950.

Nitrates[185]

Nitrate deposits of Inyo County are on the west side of the Amargosa River just north of the San Bernardino County boundary line, and in the region from Shoshone southward to the county line. The nitrate is in caliche which is associated in most places with shale or clay beds of Tertiary age but in some places with Quaternary beds. No commercial production has been obtained from the deposits.

Potash

Small amounts of Potash are associated with the salines of Owens Lake, Deep Springs Valley, Saline Valley, and Death Valley. The potash content of the deposits is too low to warrant exploitation as yet. The potash deposits of Owens Lake, Saline Valley, and Death Valley have been described by Gale[186] and that of Deep Springs Valley by Tucker and Sampson.[187]

Salt

Saline Valley has been the single source of salt or sodium chloride in the county, although the mineral is common in many of the saline areas. The salt beds of Death Valley, containing a high percentage of sodium chloride, represent enormous reserves. The Saline Valley operations, active in various periods between 1911 and 1930, have been reviewed by Tucker and Sampson.[188]

Soda

The saline deposit of Owens Lake has been exploited for many years for the production of soda ash, Na_2CO_3, and trona or sodium sesquicarbonate, $Na_2CO_3 \cdot NaHCO_3 \cdot 2H_2O$. Owens Lake was a saline lake containing carbonate, sulphate and chloride salts and occupied a closed basin. The lake is now dessicated, and the bed contains a crystal body having a maximum thickness of nine feet. The voids of the crystal body, constituting approximately one-third of its volume, are filled with brine which contains up to 35 percent anhydrous salts in solution.[189] The mineral rights of the deposit are held by the State of California, and all operations are on a lease basis.

Exploitation of this deposit started with the formation of the Inyo Development Company in 1885. At the present time there are three plants on the shore of the lake, but only one, the Pittsburgh Plate Glass Company plant, is active. This plant also produces borax.

Dub[190] has estimated that the combined total production from Owens Lake of soda ash and trona, including inferior grades of each, was 957,789 tons through 1946. The total is now undoubtedly over 1,000,000 tons.

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[185] Bailey, Gilbert E., op. cit., pp. 139-182, 1902.
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[187] Tucker, W. B., and Sampson, R. J., op. cit., p. 497, 1938.

[188] Tucker, W. B., and Sampson, R. J., op. cit., pp. 498-499, 1938.

[189] Dub, George D., Owens Lake—source of sodium minerals: Am. Inst. Min. Met. Eng. Trans., vol. 173, p. 70, 1947.

[190] Dub, George D., op. cit., p. 78.

Potential sources of soda products in Inyo County are Death Valley and Deep Springs.[191]

Natural Soda Products Company Plant. Location: On the east shore of Owens Lake 1 mile south of Keeler in sec. 9 and others, T. 17 S., R. 38 E., M.D.M. (projected); also sections in T. 16 S., R. 37 E., and T. 16 S., R. 38 E., M.D.M. (projected). Ownership: The plant is owned and operated by the Natural Soda Products Company, a division of Wyandotte Chemicals Corporation, Charles O. Chestnut, president, 506 Central Tower Building, San Francisco, California.

Brine from Owens Lake is pumped through nine miles of pipe line to 30-acre concentrating vats. The brine concentrated by evaporation from these vats, varies in Na_2O content according to the season. It is pumped from the vats to carbonating towers, where the brine is carbonated under pressure by boiler flue gas, and the precipitated solids are separated on a filter wheel. The filtered product is calcined, dried and screened.

Products are dense and light soda ash and sodium sesquicarbonate. These are shipped in sacks or in bulk. Plant capacity is approximately 20,000 tons of soda ash per year.

Power is supplied by the California Electric Co. Fifty-five men are employed when the plant is working.

Permanente Metals Corporation Plant. Location: On the west shore of Owens Lake at the Marilyn siding of the Southern Pacific Railroad in sec. 18, T. 18 S., R. 37 E., M.D.M. Ownership: The plant is owned by Permanente Metals Corporation, D. A. Rhodes, vice president and general manager, Kaiser Building, Oakland, California.

The brine from the lake is pumped four miles into tank storage, which has a total capacity of one million gallons. The brine is pumped into four carbonating towers, each 94 feet high and eight feet in diameter. Boiler flue gas is used for carbonation. The sludge is pumped to four thickeners, each 40 by 10 feet, and then filtered in an Oliver filter. Two rotary calcining units are operated at temperatures of approximately 400° F. to convert the sodium sesquicarbonate to soda ash, which can be shipped either in bulk or in sacks. The liquor is returned to the lake.

The daily productive capacity of the plant is 60 tons of soda ash. Power is supplied by the Los Angeles Department of Water and Power. Forty-five men are employed when the plant is working.

Pittsburgh Plate Glass Company Plant (Pacific Alkali Company[192]). Location: On the west shore of Owens Lake in secs. 19, 30, 31, 32 T. 17 S., R. 37 E., M.D.M. about 10 miles south of Lone Pine. Ownership: The plant is owned by the Columbia Chemical Division of the Pittsburgh Plate Glass Company.

Brine is pumped from Owens Lake through six miles of 12-inch pipe either directly to tanks in the plant or to four storage vats ranging from 15 to 50 acres in size. The brine is heated before pumping into the 16 carbonating towers, each of which is 80 feet high and 6 feet in diameter. Boiler flue gas is used for carbonation, and solid sodium sesquicarbonate is precipitated and separated from the mother liquor by centrifugal filters. The carbonate is then either dried and marketed as "Pacific Crystals" or calcined to soda ash.

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[191] King, Clarence R., Soda ash and saltcake in California: California Jour. Mines and Geol., vol. 44, pp. 190-192, 1948.

[192] Tucker, W. B., and Sampson, R. J., p. 499, 1938.

The mother liquor is chilled to precipitate crude borax, which is further dissolved, chemically treated, recrystallized, filtered and dried. The remaining liquor is returned to the lake.

The plant's annual capacity is 12,000 tons of soda ash, 12,000 tons of sodium sesquicarbonate and 2,000 tons of borax.

Power for the plant is supplied by the Los Angeles Department of Water and Power. Sixty to 75 persons are normally employed.

UNITED STATES NAVAL ORDNANCE TEST STATION, INYOKERN[193]

The U. S. Naval Ordnance Test Station embraces approximately 767,033 acres of land within Inyo, Kern, and San Bernardino Counties; about 75 percent of the station is in Inyo County. The area includes the mountainous and rugged terrain of the Argus Range and Coso Mountains in the eastern, west-central and northwestern sections, the Coso Basin in the north-central section, and the alluvial slopes and playas of Indian Wells Valley, including China Lake, in the southwestern section.

Acquisition of the area by the United States Navy was by actions filed by the United States Attorney General. The original complaint, filed February 23, 1944 (Case No. 3472-Civil), involved about 529,533 acres; the U. S. Navy took possession on February 24, 1944. A second complaint was filed March 20, 1945 (Case No. 311-N.D.) involving approximately 237,500 acres north of the original area, and possession was taken on March 30, 1945. Adjustments of the boundaries were made later which resulted in the exclusion of pumice and perlite deposits in the west-central and northwestern area as well as the exclusion of other mineralized sections in the northeastern area.

Many mining claims held by location and some patented claims, as well as other private property, were within the station boundaries. In order to reimburse the owners of mining claims, a search of the official records was made to establish ownership of such claims. The U. S. Bureau of Land Management then investigated the validity of the claims. Valid claims were in turn appraised by the Lands Division, U. S. Department of Justice, on the basis or reports by mining engineers. There remain about 72 claims upon which final action has not been taken.

Following is a summary of claim data as of March 21, 1950:

Number of reported claims	1430	(approx.)
Number of claims invalidated by the U. S. Bureau of Land Management	1216	"
Number of claims validated by the U. S. Bureau of Land Management	142	"
Number of claims under consideration	72	"

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[193] The Division of Mines appreciates the permission granted by the U. S. Attorney General's office to publish the data contained herein and the cooperation of J. F. McPherson, Special Assistant to the Attorney General, and A. Weymann, Special Attorney, Lands Division, U. S. Department of Justice in providing certain of the data. King C. Laylander, appraisal engineer, has kindly furnished the list of claims and claimants and a base map of the claim locations.

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TABULATED LIST OF INYO COUNTY MINERAL DEPOSITS

The following list is divided into three sections: metal mines and prospects, nonmetallic mineral claims, and saline deposits. The number in the first column refers to the map, plate 1. Numbers in parentheses are not shown on the map because no definite location is available. The term "proj." (for projected) is used after the location if the public land survey lines are not complete in the base map.

References given in the last column refer to the bibliography accompanying this report. Only the last name of the author is given. The first number after each name is the date of publication as given in the bibliography; the second number, that following the colon, is the page reference.

ANTIMONY

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Antimonium (Monopoly, Combination, Monarch)						See Wildrose.
1	Bishop	Mrs. Munsinger, Santa Ana (1944)	26	7S	32E	MD	(Tucker 43:58-59; herein.)
2	Darwin	F.E. Groover, 1223 Bay Ave., Balboa	12	19S	40E	MD	(Herein)
3	Hilltop (Williams and Johnson)	Archie Dean, Independence	26	21S	42E	MD	(Tucker 26: 462; 38:378, 480, pl. 3. Waring 19:62.)
	Kennedy						See Wildrose
	Lambert	C.C. Lambert, Trona and Jess Curtis, San Bernardino (1941)	--	19S	44E	MD	1½ miles E of Wildrose Springs; small tonnage of 50 per cent antimony ore shipped to Menardi Metals Co., Los Angeles
	Nemo Canyon	Farlansee Wells, Death Valley Junction (1938)	--	19S	45E	MD	(Tucker 38:378, 476, pl. 3.)
4	Old Dependable	Mrs. B.W. Belyea, 201 Hacienda Drive, Arcadia	--	19S	45E	MD	(Herein)
	Rocket	Carl Yackel, Montezuma, Colorado	29?	22S	43E	MD	Worked by open cuts. Shipped 8 tons of 38% antimony ore in 1948-49 to Harshaw Chemical Co., El Segundo
	Transportation						See Old Dependable
5	Wildrose (Monarch, Combination, Monopoly, Kennedy)	James C. Davis, 2944 The Mall, Los Angeles 23. Andrew G. Barnes (Estate), Ruth F. Bastanchury	--	19	45E	MD proj.	(Crawford 93:21; Waring 19:60-62; Tucker 21: 273; 26:462; 38:378, 480, pl. 3; White 40; herein)
	Williams and Johnson						See Hilltop

COPPER

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Anton and Pobst (Inyo)	J.C. Anton, Lone Pine. (1916)	4	16S	40E	MD	Note corrected spelling, "Pobst", not "Pabst" (Aubury 05:248; 08:306; Eric 48:238; Tucker 38:pl. 3; Waring 19:71.)
	Argus Group (Argus Copper)	A.E. Leonard, Trona (1938)	—	20S	42E	MD	(Eric 48:238; Tucker 38:468.)
	Blue Jacket	- - - -	19 20	24N	3E	SB	Greenwater district, patented claims. (Tucker 38:469, pl. 3.)
	Blue Jay	A.F. Mairs, Big Pine (1915)	15?	15S	40E	MD	(Aubury 05:248; 08:310; Eric 48:239; Tucker 26:463; 38:pl.3; Waring 19:71.)
	Brick Lode	- - - -	20	24N	3E	SB	Greenwater district, patented claim. (Tucker 38:469, pl. 3.)
	Butte	Tonopah Banking Corp., Beatty, Nevada (1929)	16	15S	41E	MD	Also gold, silver, lead. (Eric 48:239; Tucker 26:463; 38:pl. 3; Waring 19:71.)
	Copper Bar	- - - -	10, 15	23N	3E	SB	Greenwater district. (Eric 48:240; Tucker 38:471, pl.3.)
	Copper Bell	- - - -	20, 29	24N	3E	SB	Greenwater district. (Tucker 38:471)
	Copper Blue Consolidated	- - - -	20	24N	3E	SB	Greenwater district, patented claims. (Eric 48:241; Tucker 38:pl. 3.)
	Copper Glance	- - - -	27	24N	3E	SB	Greenwater district, patented claims. (Aubury 08:322; Eric 48:241; Tucker 38:471, pl. 3.)
	Copper Grand	- - - - -	13	19S	40E	MD	(Eric 48:241; Goodyear 88:226.)
6	Copper King	R. McMahan, Bishop (1926)	12?	15S	40E	MD proj.	Copper sulphides and oxides along a granite-limestone contact; worked by 2 adits and drifts. (Eric 48:241; Tucker 26:464; 38, pl. 3; Waring 19:71.)

COPPER--CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Copper King and Star	----	7?	15S	41E	MD	(Aubury 05:248; 08:309-310; Eric 48:241; Tucker 26:464; 38: pl. 3.)
	Copper Matte Consolidated	----	20, 21	24N	3E	SB	Greenwater district. (Eric 48:241; Tucker 38: pl. 3.)
	Copper Oxide	----	16	24N	3E	SB	Greenwater district. (Eric 48:241; Tucker 38: pl. 3.)
	Copper Point	----	20	8S	36E	MD	(Aubury 05:249; 08:306; Eric 48:241.)
7	Copper Queen (Oasis)	Copper Queen Mining Co., c/o W.F. Williamson, 310 Sansome St., San Francisco	12, 7	6S	36E	MD	Also tungsten. Copper oxides in three 4-5 ft. veins in limestone. Worked by open cuts and shaft. (Eric 48:249; Jenkins 42:324; Tucker 26:464; 38:pl. 3; Waring 19:73-74.)
	Copper Summit	----	35	15S	37E	MD	(Eric 48:241; Tucker 38:pl. 3.)
	Copper Tail	----	20	8S	36E	MD	(Aubury 05:249; 08:306; Eric 48:241.)
	Copper World	----	10, 11, 14, 15	7S	39E	MD	Patented claims.
	Coso (Coso Copper, Fernando, Ridgeway)	Coso Copper Co., F.H. Long, pres., Pasadena, (1938)	24	19S	40E	MD	Copper and iron oxides carrying gold and silver in 4 ft. quartz vein in limestone Worked by 175 ft. shaft and adit. 50 tons of ore shipped 1916. (Eric 48:241; Tucker 26:464; Waring 19:72.)
	Doctor	----	26	24N	3E	SB	Greenwater district, patented claim. (Tucker 38:471, pl.3.)
	Dodd's Springs-Trail	----	36	15S	41E	MD	(Aubury 05:246; 08:304; Eric 48:242.)
	Esta Bien	----	20	24N	3E	SB	Greenwater district, patented claims. (Tucker 38:472, pl.3.)

COPPER—CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Estella Fraction	----	27	24N	3E	SB	Greenwater district, patented claim. (Tucker 38:472, pl. 3 Estrella)
	Gold Crown	----	35	24N	3E	SB	Greenwater district, patented claim. (Tucker 38:472, pl. 3.)
	Gold Ring	Within U.S. Naval Ordnance Test Station, Inyokern	approx.	21S	41E	MD	(Eric 48:244.)
	Green Eyed Monster (Green Monster)	James T. Pierson, 1220½ S. Plymouth Blvd., Los Angeles	1	13S	35E	MD	Contact metamorphic deposit. Chrysocolla and other copper minerals in garnetized zone in limestone near aplite intrusive. Worked by adit. (Aubury 05:249; 08:306; Davidson 02:6; Eric 48:244; Knopf 14:120; 18:123; Tucker 26:464; 38:473, pl.3; Waring 19:72.)
	Greenwater Lode	----	2	24N	3E	SB	Also gold. Greenwater district, patented claim. (Aubury, 08:317-332; Eric 48:244; Tucker 26:464; 38: pl. 3; Waring 17:73.)
9	Hessen Clipper Nos. 1 and 2	Col. A.E. Monteith and Fred Price (locators)	15	15S	40E	MD proj.	5-6 ft. wide copper-bearing zone parallels cross fractures in limestone. Worked by 50 ft. adit and 40 ft. shaft.
	Inyo						See Anton and Pobst
	Inyo Copper Mines and Smelter Co.	----	26	15S	41E	MD	(Aubury 08:307-309; Eric 48:245; Waring 19:73.)
	Kate (Kate and Laura Consolidated)	----	19 20	24N	3E	SB	Greenwater district, patented claims.
	Kate Consolidated (Kate and Daisy Consolidated)	----	29	24N	3E	SB	Greenwater district. (Tucker 38:pl. 3.)
	Kate and Daisy Consolidated						See Kate Consolidated

COPPER--CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Kate and Laura Consolidated						See Kate
	Kempland	-----	24, 18, 19	24N	2E 3E	SB	Greenwater district.
	Kingman	----	36	19S	40E	MD	A 3-ft. vein at limestone-granite contact; mine has 2 100-ft. adits. (Aubury 05:245; 08:301; Eric 48: 246.)
10	Loretto (Loretta, Neptune)	Loretto Copper Mining Company, 141 Broadway, New York, N.Y.	16, 17, 20, 21	8S	37E	MD	Low grade oxidized copper ore in vein in granite. Worked by 1800-ft. shaft. No production. (Eric 48:247; Tucker 26:464; 38: pl. 3; Waring 19:73.)
	Morning Glory	-----	17, 18, 19, 20	24N	3E	SB	Greenwater district. (Eric 48:248; Tucker 38:476.)
	Mountain View	------	20	24N	3E	SB	Greenwater district.
	Navajo Chief	----	36	15S	40E	MD	Malachite with gold and silver in vein along granite-limestone contact. (Aubury 05:245-246; 08:303-304; Eric 48:248; Tucker 26: 464; 38: pl. 3; Waring 19: 73.)
	Neptune						See Loretto
	Oasis						See Copper Queen
	Oro Plato	-----	20	24N	3E	SB	Greenwater district, patented claims. (Tucker 38:477, pl. 3.)
	Pine Creek						See under Tungsten.
	Poco Pronto	-----	17,	24N	3E	SB	Greenwater district, patented claims. (Tucker, 38:477, pl. 3.)

COPPER—CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Rattler	----	20, 21	24N	3E	SB	Greenwater district. (Tucker 38:478)
	Red Boy	----	35, 36, 1,2	24N 23N 23N	3E 3E 3E	SB SB SB	Greenwater district, patented claims. (Tucker 38:478, pl. 3.)
11	Sally Ann	James Arnold, Orval Huffman and Sally Ann Smith, Compton	SW¼	14S	41E	MD proj.	(Herein, Mackevett 49.)
	Saratoga	----	1, 36	23N 24N	3E 3E	SB SB	Greenwater district, patented claims. (Tucker 38:478, pl. 3.)
	Settle Up	----	18	15S	41E	MD	(Eric 48:251; Tucker 26:465; pl. 3; Waring 19:p. 74.)
	Silver Hill	----	18	13S	36E	MD	A 2½ ft. vein along granite-limestone contact. (Aubury 05:248-249; 08:306; Eric 48:251.)
	Speculator	----	26, 27, 34, 35	24N	3E	SB	Greenwater district, patented claims. (Aubury 08:322; Eric 48:251; Tucker 38:479 pl.3.)
	Stewart (Orion Group)	Within U.S. Naval Ordnance Test Station, Inyokern	15	20S	38E	MD	Also gold and silver. Small lenses of low-grade copper ore in a shear zone in granite Worked by an 18-ft. 70° inclined shaft, 60 ft. adit and several 8-10 ft. deep cuts.
12	Tecopa	J.P. Madison, Robert Lee, Shoshone	approx. 10	20N	8E	SB proj.	Chalcopyrite in narrow quartz vein. Worked by 30-ft. shaft.
	Trail	----	36	15S	41E	MD	A 5-ft. vein strikes N, dips 70° E. (Aubury 05:246; 08:304; Eric 48:252.)

COPPER--CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
13	Ulida (Vlida)	——	19	15S	41E	MD proj.	Also gold and silver. Malachite, tetrahedrite, and cuprite with gold and silver in veins along granite-limestone contact. Worked by 2 adits. (Aubury 05:246, 248; 08: 304,306; Davidson 02:8; Eric 48:252; Tucker, 38: 479, pl. 3.)
	Wisconsin (Richardson)	——	25	19S	40E	MD	Oxidized copper minerals in vein. Worked by 40-ft. inclined shaft. (Aubury 05: 245; 08:301; Eric 48:253; Knopf 15:17.)

GOLD

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
14	Alabama-Mohawk	Frank Hilton, James H. Hodgman, Lone Pine (1938)	11	15S	35E	MD	Narrow quartz vein in andesite dike in granite. Worked by adits and shaft. (Tucker 38:381,468,pl.3.)
	Anderson Placers	H.W. Anderson et al Big Pine (1938)	--	10S	37E	MD	Placer gold deposit. (Tucker 38:408,468, pl.3.)
	Anthony (Gold Bug)						See Knob.
	Arctic						See Rex Montis
	Argus	Within U.S. Naval Ordnance Test Station, Inyokern	11?	23S	41E	MD	Also silver. (Tucker 38:468.)
15	Arondo (Arando)	Judge Russ Avery, 2700 W. 3rd St., Los Angeles, and estate of Alice H. MacIntosh	30	23S	43E	MD proj.	(Tucker 38:381-382, 468,pl.3.; 40:10,22; herein.)
16	**Ashford** (Golden Treasure)	Harold J. Ashford, 856 N. Coronado St. Los Angeles 26	3?	21N	3E	SB proj.	(Eric 48:244; Tucker 26:469; 38:383,473, pl.3; 40:22; Waring 19:78-79; herein.)
	Auguste (August)	C.H. Crohn, Keeler. (1938)	--	16S	38E	MD	(Davidson 02:4; Tucker 38:468,pl.3.)
	Bedell	Jim Lewis, Big Pine	--	10S	37E	MD	Placer gold deposit. (Tucker 38:408,468,pl.3; 40:22.)
17	Big Bell and Frisco Lodes (Big Bell Consolidated)	H.D. Porter, 27 Arlington Ave., Santa Barbara, and Marie Macpherson	29, 12	30N 15S	1E 46E	SB MD	(Tucker 38;469,pl.3.)
18	Big Horn	Mrs. Kate E. Gillmore, 409-19th St., Santa Monica	30 approx	14S	38E	MD proj.	Also silver, lead. High-grade ore in 4 parallel quartz veins in granite. Worked by 380-ft. inclined shaft on 3 levels and 2 adits. Altitude 6,000 ft. (Eric 48:238; Tucker 26:465-466; 34:310-311; 38:383-384, 469, pl.3.)

GOLD--CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Big Tee	Within U.S. Naval Ordnance Test Station, Inyokern	34	21S	40E	MD	Parallel quartz veins in granite. (Tucker 38:384,469,pl.3.)
	Birthday	Within U.S. Naval Ordnance Test Station, Inyokern	--	23S	41E	MD	(Eric 48:239; Tucker 38:469.)
	Bishop Creek Mining Co.						See Cardinal Gold Mining Co.
19	Black Eagle	James Wightman, Lone Pine	14 approx	13S	36E	MD	Three parallel veins near granite-limestone contact. One worked by shaft and adit. (Eric 48:239; Knopf 14:116; 18:120-121; Tucker 21: 279; 26:466; 38:384-385,469,pl.3; 40:22-23; Waring 19:75.)
20	Blue Belle	Estate of J.C.Cress (1938)	--	20S	42E	MD proj	Gold-bearing quartz vein, 4-6 ft. wide along granite-limestone contact. Worked by adits. (Tucker 38:385,469,pl.3.)
	Blue Eagle	Within U.S. Naval Ordnance Test Station, Inyokern	13?	21S	39E	MD	(Tucker 38:385.469,pl.3.)
	Blue Rock	Within U.S. Naval Ordnance Test Station, Inyokern	--	21S	40E	MD	(Tucker 38:385,469,pl.3.)
	Bonanza	Within U.S. Naval Ordnance Test Station, Inyokern	34	21S	40E	MD	Gold-bearing vein of irregular width strikes N and dips 33° W in granite. (Tucker 38:385, 469.)
	Boomerang						See Rex Montis

GOLD--CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Brown Monster (Eclipse)						See Reward. (Crawford 94:136-137; 96:180; Davidson 02:4; DeGroot 90:214-215; Erio 48:239; Tucker 26:473; 38:386-388, 469, pl. 3; 40:23; Waring 19:83.)
21	Burgess (Iron Sides)	Mrs. Kate Wells, Big Pine (1938)	--	15S	37E	MD proj.	Gold-bearing quartz vein strikes N 30° W, dips 65° W in limestone. Mine has 156-ft. shaft, 700-ft. adit, and 2000 ft. of related drifts. Ore assayed $20-$40 per ton. (Knopf 14:119; Waring 19:280.)
22	Burro and Mary F	S.H. Koehler,14272 Beaver St., San Fernando, Frank Carroll and D.D. Corum	--	20S	44E	MD proj.	(Murphy 29:114-115; Sampson 32:364; Tucker 21:281; 26:472; 38:388, 469, pl.3; herein.)
	Burro						See Burro and Mary F
	Burro, New Discovery and Gem						See Burro and Mary F, also Corona
23	Buster Brown	Gustaffison, Leavitt and Hyatt, Long Beach (1938)	8?	22S	45E	MD proj.	Gold-bearing quartz vein on contact of diorite with schist. Worked by adits. (Erio 48:239; Tucker 38:388-389, 469, pl.3.)
24	Cardinal Gold Mining Co. (Rocky Point, also Wilshire-Bishop Creek)	Cardinal Gold Mining Co., 410 Roosevelt Bldg., Los Angeles	19	8S	31E	MD	(Erio 48:239; Hamilton 20:34; Tucker 21:281-282; 26:474; 38:10; 38:389-391, 470, pl.3; Waring 19:85; herein.)
	Cashier						See Independent
25	Cecil "R"	Edward Hague and M. J. Sherlock (deceased) Trona	35	22S	44E	MD proj.	(Sampson 32:366; Tucker 38:391,470, pl.3; herein.)
	Champion	----	--	20N	4E	SB	(Tucker 26:468; 38:392,470, pl.3.)

GOLD—CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
26	Chloride Cliff (McCrea-Old Mill)	Louis McCrea, etal Beatty, Nevada (1938)	28?	30N	1E	SB	Also lead, silver. Free gold associated with galena and pyrite in quartz veins near a limestone-granite contact; 7 adits driven to work the deposit. (Ball 06:72-73; Eric 48:240; Tucker 26:467; 38:391-392, 470,pl.3; Waring 19:76-77.)
	Chrysopolis	J.D. Black, Big Pine	approx	10S	37E	MD	Chalfant 33:203; Eric 48:240.)
	Cinnamon	F.M. Hess, etal., Lone Pine (1921)	--	14S	38E	MD	Gold in quartz vein. (Tucker 21:279; 26:467; 38:392,470,pl.3.)
27	Cleveland	Mary Dunlap Mears, Big Pine (1941)	17	10S	34E	MD proj.	Free gold in a series of narrow, nearly parallel quartz veins in granite. Worked by adits and shaft. Sorted ore carried from 3 to 11 oz. of gold per ton. (Davidson 02: 4,11; Eric 48:240; Tucker 21:279-280; 26: 467; 38:392-393,470,pl.3.)
28	Commetti (Cometti Mines, Cometti Group)	LeRoi Smith, Big Pine (1941)	7, 17, 18	10S	34E	MD proj.	2 parallel quartz veins in granite are separated by an andesitic dike. Free gold occurs with pyrite and chalcopyrite. Worked by 3 adits and a winze. (Eric 48:240; Tucker 21:280; 26:468; 38:393,470,pl.3.)
	Confidence						See Confidence-Mendocino.
29	Confidence-Mendocino (Confidence)	Brigham T. Cannon, 18 E.S. Temple St., Salt Lake City, Utah	4, 5	20N	5E	SB proj.	(Tucker 26:468-469; 38:393,pl.3; herein)
30	Corona (New Discovery and Gem)	A.F. Troester, Trona, optioned to Corona Mining Co., Rene Loustalot, John F. Lee and Fred Roesser, Trona	--	20S	44E	MD proj	(Eric 48:243; Murphy 29:114-115; Sampson 32:364; Tucker 38:388,413,476,pl.3; 40:24; herein.)

GOLD—CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Cosmopolitan	Within U.S. Naval Ordnance Test Station, Inyokern	20?	20S	40E	MD	(Tucker 38:471.)
	Coso Cyanide Plant	Within U.S. Naval Ordnance Test Station, Inyokern	—	20S	40E	MD	Former cyanide plant at Coso which treated tailings from old arrastra ponds in the Coso district. (Tucker 38:393-394.)
	Coso View	Within U.S. Naval Ordnance Test Station, Inyokern	—	21S	40E	MD	(Tucker 38:394,471,pl.3.)
31	Curran	Mrs. M. Thompson, Trona	11	21S	45E	MD	(Eric 48:241; Sampson 32:366-368; Tucker 38:394,471,pl.3.)
32	Davenport	Mrs. Nellie Wilson, Trona leased to Burton Bros., Inc., Tropico	30	23S	43E	MD proj.	(Tucker 38:395,471,pl.3; 40:10; herein.)
	Davis	Mrs. J.E. Davis, Big Pine, (1938)	—	10S	37E ?	MD	Placer gold deposit. (Tucker 38:409,471,pl. 3.)
	Death Valley-Wonder	Geo. E. Cook, etal Trona, (1938)	—	17S	44E	MD	(Eric 48:242; Tucker 38:471.)
33	Del Norte	Panamint Mining and Milling Co., Roy C. Troeger, 4600 Encino Ave., Encino	13	17S	44E	MD proj	(Tucker 38:394-395,471,pl.3; 40:10,23; herein.)
34	Echo Gilt Edge (Echo-G.H.)	Bertha W. Lord, c/o I.A. Hines, Star Route #1, Barstow	1	27N	2E	SB proj.	Quartz veins in quartzite are associated with limestone and andesite. Worked by 2 shafts, 60 and 80 ft. deep. (Tucker 38:395,471,pl.3.)
	Eclipse						See Brown Monster and Reward. (Davidson 02:11; Goodyear 88:262-264.)

GOLD—CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Eclipse	R.A. Hacker, Darwin (1939)	34	19S	42E	MD	(Eric 48:242; Tucker 38:471,pl.3.)
	Emigrant	----	2, 3	29N	1E	SB	(Tucker 38:472.)
	Emigrant Springs						See Saddle Rock.
	Eureka	----	31, 32	11S	35	MD	Quartz stringers in granite; ore highly oxidized. Worked by a tunnel and shaft; idle for many years. (Eric 48:242; Knopf 14:115-116; 18:120; Tucker 26:469; 38:396,472 pl.3)
35	Finance	Ed Attaway, Lone Pine	--	17S	45E	MD proj.	One-half mile NE of Skidoo. Worked by 500 ft. tunnel. Produced $5000 net; ore averaged $28 per ton (Communication from Ed Attaway, April 1950.)
	Flapjack	----	4, 5	28N	3E	SB	Lee district. 2 patented claims. (Tucker 38:472,pl.3.)
	Gem						See Corona. (Murphy 29:114; Sampson 32:364-366; Tucker 38:413,476,pl.3.)
	Gold Basin	Within U.S. Naval Ordnance Test Station, Inyokern	14, 15	23S	41E	MD	Quartz vein in andesite porphyry. Workings are open cuts and shallow shafts. (Tucker 38:396,pl.3.)
	Gold Bird Lode						See Granite Contact
	Gold Bug						See Knob
36	Gold Dollar	Frank M. Gallaher, 509 E. Micheltorena St., Santa Barbara	5, 6,	29N	1E	SB	Patented group of claims.
			1, 12	15S	46E	MD	
	Gold	Mrs. M. Thompson, Trona	--	22S	45E	MD	South Park district.

GOLD—CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Gold Hill						See Panamint Treasure.
37	Gold King	Clarence O. Mittendorf, c/o P.H. Greer Co., 807 Equitable Bldg., Los Angeles 28	—	17S (SE¼)	44E	MD proj	A 6-8 ft. quartz vein in quartz monzonite strikes E, dips 15°S. Workings are two 60-ft. inclined shafts and 250 ft. of drifts. 1000 tons of ore shipped averaging $26 per ton. (Tucker 40:23.)
38	Gold Ridge	Western Consolidated Gold Mines, Ltd., (1938)		18S	38E	MD	Series of parallel N-S veins in granite. Worked by shafts. (Tucker 38:397,472,pl.3.)
	Gold Spur						See Lestro.
	Gold Standard						See Vega.
39	Gold Tooth (Schnellheist)	A.R. Greenslit and R.E. Baughman, Trona (1938)	24	23S	44E	MD	An 8-10 ft. vein of schistose rock cemented by quartz strikes N 10° W, dips 70° E. Wall rocks are quartzite, altered porphyry and schist. Free gold is associated with iron sulfides. Worked by adits and related workings. (Sampson 28:369-370; Tucker 38:398.)
	Gold Wedge	A.T. Wilkerson, Bishop (1938)	—	6S	35E	MD	Gold in quartz stringers is along joint planes in a schist belt 300 ft. wide. Worked by 2 shafts. (Tucker 38:398, pl.3.)
40	Golden	Mason E. Franklin, 4599 Pacific Blvd., Los Angeles	—	20S	42E	MD proj.	Between Thompson and Snow Canyons. Quartz vein worked by 3 adits. (Eric 48:244.)
41	Golden Eagle	Miss Louise Grantham, 809 E. 6th St. Ontario	—	23S	47E	MD proj.	(Herein)
	Golden Eagle	———	—	14S	37E	MD	(Tucker 26:469; 38:398,473,pl.3; Waring 19:78.)
	Golden Gate	Within U.S. Naval Ordnance Test Station, Inyokern	—	20S	40E	MD	(Eric 48:244; Tucker 38:473.)

GOLD—CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Golden Rod (Marigold)	Within U.S. Naval Ordnance Test Station, Inyokern	?	20S	39E or 40E	MD	A 6-in. to 4-ft. gold-bearing quartz vein in granite strikes E and dips 35° S Workings consist of 3 adits. (Tucker 26:471; 38:398, 473,pl.3; Waring 19:82.)
	Golden Treasure						See Ashford
	Golden Treasure						See Panamint Treasure.
42	Granite Contact (Gold Bird-Contact)	Leona M. Gove, 1289 ½ Queen Anne Pl., Los Angeles	25 30, 31	17S 17S	44E 45E	MD proj MD	(Eric 48:244; Tucker 38:pl.3.)
	Gray Eagle	Mrs. S.P. Griffith, Bishop, (1940)	10	7S	34E	MD	(Eric 48:244; Knopf 18:119; Tucker 38:pl.3.)
	Gypsy Queen (Eureka)	Frank Thomas, Big Pine, (last known owner)	—	12S	35E	MD	Free gold with chalcopyrite, chrysocolla and hematite in a series of quartz veins connected by quartz stringers in a quartz monzonite block. (Knopf 14:115-116; 18:120; Tucker 26:469; 38:399,473,pl.3; Waring 19:77.)
	Hallelujah No. 3 Placer	Dr. Vaughn, etal., San Pedro, (1938)	--	10S	37E	MD	Placer gold deposit. (Tucker 38:409-410,473, pl.3; 40:23-24.)
43	Harrisburg	Ambroise Augereberry, P.O. Box 10, Trona	16	18S	45E	MD proj.	Adjoins Independent (Cashier) mine on W. See Independent.
44	Hayseed Gold (Hayseed and State Line Lodes)	Lee Hayseed Mining Co., c/o Wm. L. Hernstadt, 551-5th Ave., New York 17, N.Y.	28, 33	29N	3E	SB	Patented claims. (Tucker 38:473.)
45	Hidden Treasure Consolidated	Lee Hidden Treasure Gold Mining Co., c/o Wm. L. Hernstadt, 551-5th Ave., New York 17, N.Y.	21, 28, 29, 32, 33	29N	3E	SB	Patented claims. (Tucker 38:473.)

GOLD—CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Hidden Treasure						See Reward.
	Highland Chief	Thomas Hancock, Lone Pine, (1938)	—	13S	37E	MD	Quartz vein in granite. (Tucker 38:399,473, pl.3.)
	Hirsh (Hirsch)						See Reward. (Crawford 96:181.)
46	Holy Roller	A.C. Porter, Trona, (1938)	—	22S	44E	MD proj.	(Sampson 32:370; Tucker 38:399,473,pl.3.; Waring 19:79.)
47	Hornspoon	Buck Johnson, Box 10, Trona	21	20S	45E	MD proj.	(Murphy 29:115; Sampson 32:370; Tucker 38: 399,473,pl.3; herein.)
48	Independent (Cashier)	Ambroise Augereberry, P.O. Box 10, Trona	16	18S	45E	MD proj.	(Eric 48:239; Tucker 26:467; 38:391, pl.3; Waring 19:75-76; herein.)
49	Inyo Gold	Frank M. Gallaher, 509 E. Micheltorena St., Santa Barbara	31, 6	28N 27N	3E 3E	SB SB proj.	Quartz veins in quartzite and schist. Finely divided free gold associated with iron and manganese oxides. Worked by inclined shaft and adit. (Tucker 38:399-401; 40, 24.)
	Iron Nugget Placer	F.B. Krater, etal Big Pine, (1938)	—	10S	37E	MD	Placer gold deposit. (Tucker 38:410,474,pl. 3.)
	Iron Sides						See Burgess.
	Josephine (Yucca)	Within U.S. Naval Ordnance Test Station, Inyokern	21	20S	40E	MD	Series of parallel quartz veins, 6 in.-2 ft. wide, in granite strike N, dip 30° E. Worked by shafts and tunnels. (Crawford 94:138; 96:181; Tucker 26:474; 38:401,424, 474,480, pl.3; Waring 19:85.)
	Journigan's	----	—	14S	38E	MD	A quartz vein in granite strikes E, dips 80° N. Free gold associated with pyrite and chalcopyrite. 150-ft. adit driven W developed a 3-ft. wide orebody, 30 ft. in length and stoped 30 ft. above adit level. (Tucker 38:401-402,474, pl.3.)

GOLD—CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
50	Journigan's Mill	Joe Stivers and John Rogers, Mojave	SE¼	17S	44E	MD proj.	(Tucker 38:401, pl.3; herein)
	July	Chas. M. Pinney, Beatty, Nevada	--	11S	43E	MD	Free gold in silicified rhyolite along fractures. Worked by adit. (Tucker 38:402, 474,pl.3.)
	Jumbo						See under tungsten.
51	Keane Wonder (Vermont)	E.L.Cord, c/o West Coast Improvement Co., 9756 Wilshire Blvd., Beverly Hills	31, 32 6	30N 29N	1E 1E	SB SB	Fine gold is associated with galena and pyrite in quartz lenses cutting schist country rock. Worked by more than 5000 ft. of drifts from 7 adits and a 200-ft. shaft. Total production since 1908 reported as $1,100,000. Some work by lessees in 1947. (Eric 48:246; Tucker 26:470; 38:402-403,474, pl.3; Waring 19:79-81.)
52	Kearsarge	Clifford T. Gates, Independence, (1938)	—	13S	33E	MD proj	Also silver. Free gold and native silver in quartz vein in quartz monzonite. Worked by adits and shallow shaft. Altitude 8000-9000 ft. (Chalfant 33:236-238; Davidson 02:6; Tucker 21:280; 26:470; 38:403,474,pl.3.)
53	Keeler (Kruger)	Joe Cook Estate, Keeler	approx. 13	17S	38E	MD proj.	Free gold in vein in limestone. Worked by 250-ft. vertical shaft with levels at 70, 130 and 250 ft. Cyanide mill, which also treated custom ore, converted to tungsten mill - see West Coast Tungsten Co. (Eric, 48:246; Tucker 38:10; 38:403-404,474,pl.3; 41; 574.)
54	Keynote (Key Not, Golden Princess)	Golden Princess Mining Co., Lone Pine (1938)	—	14S	37E	MD proj.	Two quartz veins in granite carry free gold associated with pyrite and chalcopyrite. Principal work on Keynote, vein is 7 adits War Eagle vein worked by 3 adits. Total reported production $500,000. (Burchard 84; 159; Crawford 94:138; 96:181; Davidson 02:8, 11; Knopf 14:112; 18:118; Tucker 26:470; 38: 404-405,474,pl.3; Waring 19:81.)

GOLD—CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
55	Knob (Anthony Gold Bug)	E.A. and O.F. Shafter, Kisk Estate, P.O. Box 1048, Trona	7	22S	45E	MD proj.	(Eric 48:238; Murphy 29:121-122; Sampson 32:368-369; Tucker 38:381,468,pl.3; herein.)
	Krater-Van Norman	F.B.Krater, etal., Big Pine	—	10S	37E	MD	Placer gold deposit. (Tucker 38:410,474,pl.3.)
	Last Chance	L.V. Twining, R.C. Coryell, S.M. Basher, Los Angeles (1938)	—	21N	4E	SB	Quartz vein in schist. Worked by adits. (Tucker 26:470; 38:405.)
	Lead Hill	——	17, 20	12S	37E	MD	(Tucker 38:475,pl.3.)
56	Lestro Mountain (Gold Spur)	Mrs. J.H. Lester, San Francisco	--	24S (NW¼)	45E	MD proj	(Tucker 26:469; Waring 19:77-78; herein.)
	Lewis	J.C. Lewis, Big Pine	—	10S	37E	MD	Placer gold deposit. (Tucker 38:411-412,475 pl.3; 40:24.)
57	Little Mack	Otto Seidentopf, Trona	34	19S	42E	MD proj.	A series of parallel quartz veins conform to bedding planes of enclosing limestone; strike N 20° E, dip 50° S. Veins 2 to 4 ft. wide carry gold associated with lead carbonate. Worked by 2 adits, 250 ft. and 20 ft in length, and an inclined 80-ft. winze. One stamp mill on property. (Tucker 38:405-406,475,pl.3.)
58	Lost Burro	W.C. Thompson, Caliente	16	14S	41E	MD proj.	Fissure veins in granite worked by several adits and 2 shafts. (Tucker 26:470-471; 38:406,475,pl.3; Waring 19:81-82.)
59	Lotus (Monte Cristo)	Lotus Mines, Inc., B.C. Flint, pres., 1524 N. Buena Vista St., Burbank	16, 17	24S	45E	MD proj	(Herein)

GOLD—CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Lucky Bill	E.R. Elliot, et al Bishop (1938)	—	6S	30E	MD proj.	Some free gold with pyrite, sphalerite and chalcopyrite in narrow quartz vein in granite. Worked by adits and open cuts. (Tucker 26:471; 38:406,475,pl.3.)
	Lucky Boy	Geo. V. Parker, Independence (1938)	—	13S	34E	MD proj	Quartz veins in granodiorite. Worked by one short adit. (Tucker 38:406,475,pl.3.)
	Lucky Red	Within U.S. Naval Ordnance Test Station, Inyokern	23	21S	40E	MD	(Tucker 38:406,475,pl.3.)
	Lucky Strike						See Sunrise View.
	Luella (Abe Lincoln)	J.C. McDonald, Ventura, (1938)	—	14S	35E	MD	Free gold associated with hematite, pyrite and chrysocolla in narrow quartz stringers along joints in a felsite dike in granite Several adits. (Crawford 94:139; 96:182; Tucker 38:406,475,pl.3.)
60	Magpie	C.C. Cunningham, 120 S. Grand Ave., Los Angeles	—	10S	37E	MD proj.	Two systems of quartz veins, one striking E and one N, occur in limestone. 18 in. to 2 ft. samples of ore reported to assay $3-30 per ton in gold, 10-20 oz. silver, and 3 to 10% lead. Worked by shallow shafts. (Tucker 38:407,475, pl.3.)
	Mamie	Within U.S. Naval Ordnance Test Station, Inyokern	17	20S	40E	MD	(Tucker 38:407,475,pl.3.)
	Mammoth	Within U.S. Naval Ordnance Test Station, Inyokern	3	23S	41E	MD	A 4-ft. quartz vein in granite strikes E and dips 70° S; contains hematite, pyrite and chalcopyrite. Worked by adits. (Eric 48:247; Tucker 38:407,475,pl.3.)
61	Marble Canyon Placers	Helah Anderson, David T. Bedell, Big Pine, (1938)	—	10S	37E	MD proj.	Placer gold deposit. (See also Anderson, Bedell, Davis, Hallelujah No. 3, Iron Nugget, Krater-Van Norman, and Lewis placer mines.) Tucker 38:

GOLD—CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
61	Marble Canyon Placers (Continued)						407-408,475,pl.3.)
62	**Margaret**	**George Halverson,** 611 Financial Center Bldg., Los Angeles	31	23S	43E	MD proj	(Tucker 38;pl.3.)
63	Margaret (World Beater)	D.H. Claire, Box 5 Trona	9	22S	45E	MD proj	Two 12-ft quartz veins in granite gneiss Relocated by D.H. Claire in 1930. Reported by Claire to have produced $185,000 before 1930 and $75,000 from 1936 to 1942. Worked by 50-ft. shaft and 3 tunnels. (Davidson 02:8,11,; Sampson 32:376; Tucker 38:480.)
	Marigold						See Golden Rod.
	Mariposa	Within U.S. Naval Ordnance Test Stations, Inyokern	20	20S	40E	MD	Quartz vein strikes NW, dips 45° NE. Worked by several shafts. (Crawford 95:139; 96:182; Tucker 38:475,pl.3.)
64	Mature and Los Angeles (Mature)	Cora M. Mitchell, c/o Vincent Wray, Box 887, Whittier	---	23S	44E	MD proj	(Tucker 38:475,pl.3.)
	Mature						See Mature and Los Angeles
	Maxmaur-Marguerite	Within U.S. Naval Ordnance Test Station, Inyokern	21?	20S	40E	MD	(Tucker 38;475.)
	Max Welton	Jack Stuart, Darwin (1940)	---	17S	44E	MD proj.	Five unpatented claims 2 ft. thick, 500 ft. wide blanket vein assaying $2 per ton. Worked in 1934.
65	Mazourka Canyon Placer	Various	---	12S	36E	MD proj	Gold in placer deposits. (Crawford 94:139; 96:182; Davidson 02:9,Knopf 14:112; 18:118; Laizure 34:245; Tucker 38:411,476,pl.3.)
	McCrea						See Chloride Cliff.

GOLD—CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
66	McKinley-Westphalia (Westfalia)	Cora M. Mitchell, c/o Vincent Wray, P.O. Box 887, Whittier	24	23S	42E ? 43E	MD	Patented claims. (Tucker 38:480,pl.3.)
	Merry Christmas						See St. George.
	Moffat	J.W. Brown, et al., Bishop, (1938)	—	8S	31E	MD proj	Quartz vein in granite. Two shafts. (Tucker 38:411,476,pl.3.)
67	Mohawk	J.C. Boyles, Trona. Under lease to Homewood Mining Company and Burton Bros., Inc., Tropico	6	24S	43E	MD	(Tucker 38:10, 411-412,476, pl.3; 40:10,24; herein.)
	Monte Cristo						See Lotus.
	Mountain Boy	Marblehead Land Co. c/o Mrs. Merritt H. Adamson, 1801 S. La Cienega, Los Angeles	—	22S	45E	MD	South Park district, patented claims.
68	Mountain Girl	Harry C. Porter, (deceased)	1	22S	45E	MD proj.	Several small quartz veins in schist carry coarse, free gold. Worked by tunnels and a shaft. (Sampson 32:370-371.)
	Mountain Springs Canyon (Bonanza)	Within U.S. Naval Ordnance Test Station, Inyokern	7, 8, 9, 17, 18	23S	41E	MD	A series of quartz veins containing gold and silver associated with pryite and chalcopyrite strike N 30°- 40° E and dip 30°-40°NW. Workings are 2 shafts and drifts. (Crawford 94:136; 96:180; Tucker 38:412,476, pl.3.)
	Mountain Springs Canyon Placers	Within U.S. Naval Ordnance Test Station, Inyokern		23S	42E	MD	(Tucker 38:413,476,pl,3.)
	Mountain View						See Rex Montis

GOLD—CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
69	Napoleon	Ambroise Augereberry, P.O.Box 10, Trona	21	18S	45E	MD	(Herein.)
	New Discovery and Gem						See Corona
70	New Era (Buckeye, Never Rest)	W.C. Hove, Big Pine	26, 27	10S	34E	MD	(Eric 48;249; Tucker 21;279; 26;466; 38;3; herein.)
	Ninety-Eight Quartz and Placer	Within U.S. Naval Ordnance Test Station, Inyokern	10	21S	40E	MD	(Tucker 38;477.)
	Noon Hour	Truman Wiggins, 1702 Waterman Ave., San Bernardino	—	10S	37E	MD	Gold placer deposit. 160-ft. shaft and 300 ft. of drifts. Produced less than $500. (Communication from Truman Wiggins, March 1950.)
71	O.B.J. (Tyler, O.B. Joyful, Panamint Mines Co.)	G.W.Tyler, et al., Trona (1938)	9	20S	44E	MD proj.	Gold and lead ore in crushed quartz veins and schist wall rock; worked by several adits and shafts. Described by Sampson (see below). (Sampson 32;371-372; Tucker 26;465; 38;413-414,477,pl.3.)
	O.B. Joyful						See O.B.J.
	Olympic	Within U.S. Naval Ordnance Test Station, Inyokern	—	21S	41E	MD	A 200-ft. tunnel driven to work a 4-ft. vein in quartz diorite. (Tucker 38:414,477,pl.3.)
	Orion	Within U.S. Naval Ordnance Test Station, Inyokern	20	20S	40E	MD	Two veins worked by an inclined shaft and adit. High gold content reported of narrow stringer in shaft. (Tucker 38;414,pl.3.)
	Oro Grande Placer	Within U.S. Naval Ordnance Test Station, Inyokern	29	20S	40E	MD	(Tucker 38;414,477,pl.3.)
	Palma						See Saddle Rock.
	Panamint Mines Co.						See O.B.J.

GOLD—CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
72	Panamint Treasure (Taylor, Treasure, Gold Hill)	Miss Louise Grantham, 809 E. 6th St., Ontario	19	22S	47E	MD proj	(Eric 48:244; Sampson 32:369; Tucker 38:397, 472, pl.3; herein.)
	Pittsburg	J.H. Riddle, et al	36 1	21N 20N	5E 5E	SB SB	(Tucker 38:477,pl.3.)
73	Poleta (Polita)	A.E. Beauregard, Bishop	7, 8	7S	34E	MD proj	Gold, some free, associated with pyrite and limonite in narrow quartz vein in limestone. Worked by a 400-ft. adit and a 600-ft. inclined winze. (Crawford, 94:139; 96:183; Davidson 02:7,11; Eric 48:249; Tucker 38:10; 38:414-415,477,pl.3; 40:24,25.)
74	Pumpkin	Pumpkin Consolidated Mining Co., c/o Wm. L. Hernstadt, 551-5th Ave. New York 17, N.Y.	32	29N	3E	SB proj	Patented claims.
	Radcliff						See Ratcliff.
	Rainbow	Beebe Mining Co. (1939)	--	21S	38E	MD	Six claims 8 miles SE. of mill at Haiwee Reservoir. Mill equipment includes two 1500 lb. stamps, Gibson amalgamator, concentrating table.
75	Rainbow	A.W. Plummer, 2062 Glencoe Way, Hollywood (1938)	12, 21, 22	22N	7E	SB	Low-grade gold ore in a series of parallel veins in andesite. Worked by shallow shafts and open cuts. (Tucker 38:415,478,pl.3.)
76	Ratcliff (Radcliff)	Mrs. W.D. Claire, P.O. Box 5, Trona	8	22S	45E	MD proj.	(Murphy, 29:118-120; Sampson 32:373-376; Tucker 26:472; 38:415,477,pl.3; 40:25; Waring 19:83; herein.)
	Red Hill	Within U.S. Naval Ordnance Test Station, Inyokern	12?	20S	38E	MD	(Tucker 38:478.)

GOLD--CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Red Mexican	Within U.S. Naval Ordnance Test Station, Inyokern	approx	20S	39E	MD	Narrow quartz vein worked by vertical shaft, levels and an adit connecting with shaft on 100-ft. level. 8 tons of ore shipped netted $152. (Tucker 38:415,478,pl.3.)
	Red Robbin	Within U.S. Naval Ordnance Test Station, Inyokern	--				18 miles SW of Darwin. Three short adits driven on 2-ft. quartz vein striking N. 40° W, dipping 40° E.
	Red Rock	Within U.S. Naval Ordnance Test Station, Inyokern	5?	21S	40E	MD	(Tucker 38:478.)
77	Reward (Brown Monster, Brown Monster-Reward, Eclipse, Hidden Treasure, Hirsh, Reward-Brown Monster, Telescope)	Basil Prescott, Beverly Hills	3	14S	36E	MD proj.	(Burchard 84:160; Davidson 02:7,11; Eric 48:250; Knopf 14:116-119; 18:121-122; Tucker 26:473; 38:386-388,478,pl.3; 40:23; Waring 19:83; herein.)
78	Rex Montis (Arctic Boomerang, Ibex, Mountain View)	Omie Mairs, Independence, and A.P. Conklin and associates, San Francisco	--	13S	33E	MD proj	Gold in quartz vein in quartz monzonite. Worked by adits. In 1872, 12,333 oz. of gold and silver produced. Altitude 12,000 ft. (Davidson 02:7,11; Knopf, 18:124; Tucker 38:415-416,478,pl.3.)
	Rock Point (Cardinal, Rocky Point, Wilshire-Bishop Creek)						See Cardinal Gold Mining Co.
79	Rosario	----	31, 32	28N	3E	SB proj.	Patented claims. (Tucker 38:478.)
	Ross	Within U.S. Naval Ordnance Test Station, Inyokern	approx	20S	40E	MD	(Eric 48:250.)
	Ruiz	R.C. and R.E. Ruiz Lone Pine (1938)	--	18S	40E	MD proj	Free gold in quartz-filled fissure in quartz monzonite. Worked by 65-ft. shaft. Tucker 38:416,pl.3.)

GOLD--CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
80	Ruth (Graham-Jones)	F.L. Austin, Trona, Graham Estate, Porterville, and H.R. Evans, Kernville. Leased to Burton Bros., Inc., Tropico	35	23S	42E	MD	(Tucker 38:10,416-418,478,pl.3; 40:10,25; herein.)
81	Saddlerock (Imigrant Springs)	Wm. C. Thompson, c/o Tungsten Chief Mine, Caliente	35	17S	44E	MD proj.	Quartz-filled fractures in quartzite; potential large low-grade deposit with occasional high-grade pockets found in fractures near surface. Tucker 38:395-396,478,pl.3.)
82	St. George (Merry Christmas)	J.C. Cress, et al. (1938)	--	20S	42E	MD proj.	(Tucker 26:471; 38:418-420,479,pl.3; herein)
	Scotchman	----	13	22S	44E	MD	South Park district, patented claims. (Tucker 38:478.)
	Senator	----	32, 5	11S 12S	35E 35E	MD MD proj.	(Davidson 02:7; Tucker 38:478,pl.3.)
	Silver Bell						See Skidoo.
83	Skidoo (Silver Bell)	W. Howard Gray, Ely, Nevada	19 or 20	17S	45E	MD proj.	(Tucker 26:473; 38:420-421,479,pl.3; 40:10; Waring 19:83-84; herein.)
84	Southern Homestake (Southern Homestead)	Harry E. Briggs, Trona	18	23S	45E	MD proj	(Tucker 38:421,479,pl.3; herein.)
	Southern Homestead						See Southern Homestake.
85	Squash	Lee Hidden Treasure Gold Mining Co., c/o Wm. L. Hernstadt, 551-5th Ave. New York 17, N.Y.	28, 29, 32, 33	29N	3E	SB proj.	Patented claims. (Tucker 38:479.)

GOLD--CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Star of the West (Star de West)	Within U.S. Naval Ordnance Test Station, Inyokern	4, 5, 8, 9	24S	41E	MD	A 3-ft. quartz vein in granite strikes NW and dips 20°SW; worked by several adits 50 ft. to 100 ft. in length. An 18 in. vein SE of above adits worked by shallow shaft. (Tucker 38:421,479,pl.3.)
	State Line						See Hayseed.
86	Stockwell	Stockwell Gold Mining Co., c/o E.E. Teagle, Box 597, Trona	14 (mill)	24S	43E	MD proj.	Mill is in sec. 14; mine is 3 miles NE of mill. (Eric 48:251; Tucker 38:422-423,479,pl. 3; herein.)
	Sunrise View (Lucky Strike and Sunrise View)	A.C. Zell, Lone Pine (1938)	—	15S	36E	MD proj.	Pockets of high-grade gold ore in quartz stringers and veins in a lime-silicate rock along shear zone in granite. Worked by adits and shafts. (Tucker 38:423,475,479, pl.3.)
87	Sunset	W.M.G. Walters, Box 1143, Trona	29 or 30	17S	45E	MD proj.	(Herein.)
	Taylor						See Panamint Treasure.
	Telescope						See Reward. (Davidson 02:8; Tucker 38:479.)
	Tip Top	C.A. Caldwell, Fairmont (1939)	—	22S	45E	MD proj.	(Eric 48:252; Tucker 38:479.)
	Tom Casey	Tom Casey, Lone Pine (1938)	—	13S	37E	MD	Quartz vein worked by 3 adits. (Tucker 38: 423,479,pl.3.)
	Treasure						See Panamint Treasure.
88	Treasure Hill	L.E. Mendelman, I. Kusnick, Paul Cores and Albert King, Los Angeles (1938)	approx	17S	45E	MD proj.	Five parallel veins in granitic gneiss strike N, dip 40°E; widths range from 1 to 4 ft. Free gold is associated with galena and pyrite. Worked by shafts and tunnels. (Tucker 38:423,479,pl.3.)

GOLD—CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
89	Tucki	Roy I. Journigan, 709 E. Beverly Blvd., Whittier Ed Attaway, Lone Pine	—	17S	45E	MD proj.	(Tucker 38:10; 479; herein.)
	Tyler						See O.B.J.
	Vega (Gold Standard)	Col. A.E. Monteith et al. Keeler,	--	14S	38E	MD	Also silver, copper. Two quartz veins in quartz monzonite. Gold Standard vein crops out for 2100 ft. Worked by 4 adits. Ore shipments assayed 3 oz. gold, 58 oz. silver and 11% copper. (Tucker 38:397-398,472, pl.3.)
	Vermont						See Keane Wonder.
	Vernon						See Stockwell.
90	Victor (Victor Consolidated)	Earl J. Lake, 8717 Rangely Ave., Los Angeles 36, and Mary D. Reed Estate	3, 9, 10, 15	8S	37E	MD	(Tucker 38:480,pl.3.)
	Vin Blanco	Within U.S. Naval Ordnance Test Station, Inyokern	approx	20S	40E	MD	Quartz vein, 6 in.-2 ft. wide, in granite; worked by 2 shafts, 100 ft. and 80 ft. deep. (Tucker 38:424,480,pl. 3.)
	Virginia	Virginia Consolidated Mining Co., c/o Al G. Benard, Room 403, 704 Market St., San Francisco 2	—	13S	33E	MD	(Tucker 38:480.)
	Wahoo	W.M. Hoover, Lone Pine (1939)	approx	18S	40E	MD	A 3 to 4-ft. vein in quartz monzonite; worked by 90-ft. shaft and 150-ft. drift on 90-ft. level. (Eric 48:252; Tucker 38: 424; 40:25.)

GOLD--CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Westfalia						See McKinley-Westfalia. McKinley-Westphalia
	West Point	Within U.S. Naval Ordnance Test Station, Inyokern	31?	23S	42E		(Tucker 38:480.)
	Wilshire Bishop Creek						See Cardinal Gold Mining Co.
	World Beater						See Margaret
	Wonder	----	--	20N	5E	SB	Gold and copper in quartz vein. Worked by two 75-ft. shafts. (Tucker 26:474; 38:424, 38:424,pl.3; Waring 19:85.)
	Yucca						See Josephine.

IRON

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Big 4 Nos. 1,2 and 3						See Millspaugh.
91	Coso	G.W. Dow, Lone Pine	--	19S	39E	MD proj.	Hematite and magnetite in veins worked by open cuts. U.S. Bur. Mines estimates 3,000 to 15,000 tons of ore. (Tucker 26:475; 38:425,471,pl.3; Waring 19:87.)
	Hoot Owl						See Iron Cap.
92	Iron Cap (Hoot Owl, Monarch Iron Consolidated, Primus)	Percy J. Hagerman, (Trustee) c/o El Paso Club, Colorado Springs, Colorado	28-30	22S	43E	MD proj.	(Crawford 94:326; Egenhoff 48:291-292; Tucker 38:17; 38:425,pl.3; herein.)
	Iron Chief and Ferro	Within U.S. Naval Ordnance Test Station, Inyokern	13	23S	41E	MD	(Crawford 94:326; herein.)
	Iron Chief	Within U.S. Naval Ordnance Test Station, Inyokern	18	23S	42E	MD	(Herein.)
	Iron Gossan (Kingston Mountain, Beck)		34, 35 2	20N 19N	10E 10E	SB SB	In Inyo and San Bernardino Counties. See Kingston Mountain Iron Deposit, San Bernardino County. (Hewett 48:201-205)
93	Le Cyr (Valley View)	J.R. LeCyr, c/o Santa Rosa Mining Co., Keeler	1	19S	38E	MD proj.	(Tucker 26:475; 38:425,475,pl.3; herein.)
	Mary Roper						See Roper.
	Millspaugh (Big 4 Iron Nos. 1,2 and 3.)	Within U.S. Naval Ordnance Test Station, Inyokern	4	22S	42E	MD	(Tucker 46:319; herein.)
94	Mister	Lance Smith, Puente, L.S. McGirk and L.S. McGirk,Jr., 3428 Freer St., El Monte	24, 19	21N 21N	4E 5E	SB proj SB proj.	(Burchard 48:229; herein.)

IRON—CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Monarch						See Iron Cap.
	Primus		30	22S	43E	MD	See Iron Cap. Incorrectly located on pl. 3, Tucker 38.
	Raven	F.L. Collins, J.R. Reilly, 137 E 22nd St., New York, N.Y. (1943)	approx 20	21N	5E	SB	Specular hematite in granite gneiss. (Burchard 48:229.)
95	Roper (Mary Roper)	----	--	13S	36E	MD	Specular hematite with gold. Worked by adit and shaft. (Tucker 21:282; 26:475; 38:425, pl.3; Waring 19:87.)
	Valley View						See Le Cyr.

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Ajax						See New Southerland Divide Mining Co.
	Alabama						See Panamint. (Crawford 94:374; Davidson 02:4; Tucker 38:468, pl.3.)
	Alexander						See Shoshone. (Sampson 37:268.)
	Alvah	Ingvald C. Boe, Box 123, Morro Bay	1	16S	38E	MD	Probably lead-silver. (Tucker 38:468, pl.3.)
96	American	J.W. Stalker, Shoshone	approx 27	21N	5E	SB proj.	Argentiferous tetrahedrite, chalcopyrite, and galena with some gold in narrow vein. Worked by adits and shallow shaft. (Eric 48:238; Tucker 26:476; 38:427,468,pl.3; Waring 19:71.)
	American Eagle						See Wallace Wonder. (Tucker 38:468.)
	American						See Gold Bottom.
	American Silver Corp.	American Silver Corp., Beverly Hills (1949)	—	21S	45E	MD	Herein.
97	Anaconda	Panamint Mining Co. (1932)	4	21S	45E	MD proj.	Also gold. Patented claim near Panamint City. (Murphy 32:5; Tucker 38:pl.3.)
	Apex Consolidated						See Shoshone. (Tucker 38:468,pl.3.)
	Arcturus						See Ibex.
98	Argenta	George Greist, Box 10, Trona	27?	18S	45E	MD proj.	Also gold. (Tucker 43:59; herein.)
	Argus-Sterling	Within U.S. Naval Ordnance Test Station, Inyokern	26	20S	41E	MD	Quartz-filled fissure in limestone near granite contact. Worked by 155-ft. shaft and 450-ft. adit. (Eric 48:238; Newman 23:740-741; Tucker 21:283; 26:476-477; 38:427, 468,pl.3.)

LEAD, SILVER, AND ZINC--CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Aries Consolidated						See Cerro Gordo. (Tucker 38:468,pl.3.)
	Armagh (Armaugh)						See Cerro Gordo. (Davidson 02:4; Tucker 38:468,pl.3.)
	Augereberry	Ambroise Augereberry, P.O. Box 10, Trona	24?	18S	45E	MD proj.	Two miles E of Independent mine. Quartz vein in limestone worked by 3 adits.
	Bachelor No. 2	J.V. Lehigh, Los Angeles (1932)	--	21S	45E	MD	(Murphy 29:108; Sampson 32:359.)
99	Baxter	J.P. Madison, Shoshone	3	23N	7E	SB proj.	Replacement in dolomite; (Eric 48:238; Hazzard 37:298; Tucker 21:283; 26:477; 38:427,468,pl.3; Waring 19:88.)
100	Bedell (Daisy LeRoy)	David T. Bedell, Big Pine	--	10S	37E	MD proj.	Galena and cerussite in fissures in limestone striking N 30° W and dipping 45° E. Worked by adits and inclined shaft. (Newman 23:421; Tucker 21:285; 26:483; 38:427-428,468,pl.3; Waring 19:94.)
101	Belmont	W.L. Hunter Estate and Beveridge Hunter, Olancha	19	16S	39E	MD proj.	High-grade silver ore with some lead and copper in quartz veins. Worked by adits and shaft with more than 3600 ft. of underground workings. Reported production of $500,000. (Crawford 94:23; 96:32; Eric 48:238; Goodyear 88:250-254; Tucker 21:283; 26:477; 38:428,468,pl.3.)
	Bernon (Burnon)						See Darwin. (Butner 49:5; Crawford 94:24; Kelley 38:pl.6,7; Stewart 49:56; Tucker 38:469,pl.3.)
102	Bertha Ann	F.G. Brown, 3073 W. 12th Place, Los Angeles, Mrs. Bertha Hartz, Katherine Brown, and Frank Grouch	2	19S	41E	MD proj.	Zinc carbonate in dolomite. Workings are open cuts. (Oral communication from F.G. Brown, June 1950.)

LEAD, SILVER, AND ZINC--CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
103	Big Four (War Eagle)	Mrs. Agnes Reid, Panamint Springs; Silas Ness, Olancha William Braun, Bishop, Marie Keck, Los Angeles	25	17S	42E	MD proj.	Herein.
104	Big Silver (Essex)	Saline Valley Mining Co., A.B. Ganfield, pres., 247 S. Ardmore St., Los Angeles	--	14S	38E	MD proj.	Described by Tucker 26. (Eric 48:238; Tucker 26:477-478; 38:428,469, pl.3; 40:25-26.)
	Big Wedge						See Monte Carlo
105	Bishop Silver-Cobalt	Jack O'Brien et al, Bishop, (1938)	14	9S	31E	MD	Silver, gold, copper, cobalt and traces of nickel occur as a lode deposit in a contact area of crystalline rocks and dolomite; worked by open cuts and an adit. (Tucker 38:378-379,469,pl.3.)
	Black Canyon						See Black
106	Black Canyon (Black Caynon , Mineral Point, Sanger)	Morris Albertoli and associates, Big Pine	13, 14, 23, 24	7S	34E	MD proj.	(Eric 48:247; Tucker 26:489-490; 38:426,444-445,476,pl.3; herein.)
	Black Cap	Lemke Bros., Laws, (1934)	approx	7S	37E	MD	Six miles east of Deep Springs Ranch. (Eric 48:239.)
	Black Prince						See Shoshone. (Tucker 38:469.)
	Black Rock	William Adams and associates, Tecopa (1926)	--	20N	8E	SB	Ore in lenses along fissure in dolomite. Developed by 2 adits, one 900 ft. in length (Tucker 26:478-479; 38:428-429,469,pl.3.)
	Blue Bird						See Red Eagle.
	Blue Dick						See Midnight.

LEAD, SILVER, AND ZINC--CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Blue Monster						See Monster.
	Bluff						See Cerro Gordo. (Tucker 38:469.)
	Boushey Silver (Baushey)						See Cerro Gordo. (Tucker 38:468,pl.3 Bonshey).
	Brownie	A.J. Sebastian, 6508 Kansas Ave., Los Angeles (1942)	--	6S	34E	MD proj.	Nine miles E of Laws, Calif. Galena and lead carbonate ore bodies along limestone-schist contact. Assays 6.55-5.95% lead.
	Buckhorn	Andrew Sundberg, Darwin	--	19S	40E	MD	
107	Bull Domingo	P.N. Johnson, 302 E. Anaheim Blvd., Long Beach (1938)	15	6S	35E	MD	Galena and cerussite in fissure along contact between limestone and schist. Worked by shaft and adits. (Eric 48:239; Tucker 34:311; 38:429,469,pl.3.)
	Bunker Hill	Bunker Hill Mining Co., 689 "E" St., San Bernardino	--	6S	35E	MD	Replacement bodies in limestone. Worked by 600-ft. shaft and adit. (Tucker 21:283; 26:479; 38:426,429,469.)
	California Smelting and Refining Co.	California Smelting and Refining Co.	--	19S	41E	MD proj.	Lead concentrating mill in Darwin Wash. Dismantled. (Tucker 38:430,470,pl.3.)
108	Camp Bird	J.V. Leigh, Los Angeles (1938)	--	21S	45E	MD proj.	Two quartz veins of 15-ft. maximum widths in limestone. Worked by an adit and drifts totaling 400 ft. in length and a winze sunk on a vein from the adit level to a depth of 150 ft. (Murphy 29:106-107; Sampson 32:360-361; Tucker 26:479-480; 38:430,470,pl.3.)
	Carbonate (Queen of Sheba)						See New Sutherland Divide Mining Co.
109	Cerro Gordo (Aries Consolidated, S½ Armagh, Bluff, Boushey Silver, Ignacio or Ygnacio, Mor-	W.C. Rigg and associates, 595 E. Channel Rd., Santa Monica	12, 13, 23, 24 18	16S 16S	38E 39E	MD proj. MD	Chalfant 33:277-283; Crawford 94:24-25, 374; DeGroot 90:213-214; Eric 48:239; Goodyear 88:250: Hamilton 20:37; 22:48; Knopf 14:95-109; 18;106-116; Merriam 49:82; Newman 23:420; 23:30; Stewart 49:56; Tucker 21:284;

LEAD, SILVER, AND ZINC--CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Cerro Gordo (Cont'd) mon, New Enterprise, Omega, Pagan, Santa Maria, Summit No. 2 and Union)						24:33; 20:185-187; 26:480-482; 34:311; 38:426,431-433,470,pls.3,4; Waring 19:90-92; herein.)
	Cerro Gordo Extention						See Royal. (Eric 48:240; Tucker 38:433-434, 470,pls.3,4.)
110	Cerrusite	Mrs. Agnes Reid, Panamint Springs via Lone Pine	7	16S	40E	MD proj.	Four tunnels driven to work a vein in limestone; vein strikes NE, dips 40°N ore minerals chiefly silver-bearing concentrated in streak, 2-8 inches wide. Leased to Bill James, Lone Pine (1948). (Tucker 38:434,470, pl.3.)
	Challenge						See Panamint. Part of Stewart's Wonder. Davidson 02:4; Murphy 29:104-105; Sampson 32:363; Tucker 38:470.)
	Chalmers						See Westgaard.
	Chesamac	Donald McDonald, Los Angeles (1938)	--	20S	45E	MD	(Sampson 32:361; Tucker 26:482; 38:434-470, pl.3.)
111	Christmas Gift	L.D. Skinner, Lone Pine, L.V. Skinner, 247½ N. Virginia St., Reno, Nevada	11	19S	40E	MD	(Chalfant 33:132; Crawford 94:24; DeGroot 90:210; Eric 48:240; Goodyear 88:226; Kelley 38:554-555,pl.5; Knopf 15:10-12; Tucker 21:284-285; 26:482; 38:434,470,pl.3; Waring 19:92; herein.)
	Cliff	? Greenley and Broder, Deep Springs (1888)	--	6S	36E	MD	Rich silver ore in narrow quartz veins in granite. (Goodyear 88:237; Tucker 21:285; 26:482; 38:434,470,pl.3; Waring 19:93.)
	Colorado						See Zinc Hill. (Tucker 38:470.)
	Columbia						See Darwin. (Davidson 02:4; Eric 48:240; Kelley 38:561,pl.7; Knopf 15:17-18; Tucker

LEAD, SILVER, AND ZINC—CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Columbia (Cont'd)						21:285; 26:482-483; 38:435,470,pl.3; Waring 19:93.)
	Columbia No. 2 (Columbia)						See Shoshone. (Eric 48:240; Sampson 37:268; Tucker 43:120.)
	Comstock	----	4	21S	45E	MD	(Davidson 02:5; Tucker 38:470,pl.3.)
	Copper Bell						See Ubehebe.
	Copper Queen No. 2						See Gold Bottom.
112	Custer	Long and Grimes, Pasadena (1938)	24	19	40E	MD	Irregular bunches of galena and cerussite with pyrite and iron oxides in a body of very coarsely crystalline calcite in tactite Some copper minerals. Worked on 5 levels from a 335-ft. inclined shaft. 50 tons of ore shipped by lessee in 1940-41. (Aubury 08:314; Davidson 02:5; Eric 48:241; Kelley 38:560; Knopf 15:15-16; Tucker 21:285; 26: 482-483; 38:426,435,471,pl.3; Waring 19: 93-94.)
113	Custer	F.H. Long, Altadena	28, 29	12S	36E	MD proj	Galena and cerussite carrying silver and gold occur along a contact between limestone and granite in a zone 4 to 6 ft. wide. Some Copper. Worked by 2 adits. (Eric 48: 241; Tucker 38:435,470.)
	Darwin Cyanide Plant	----	---	20S	41E	MD proj.	Operated by Louis Warnken, Jr. on tailings of the Darwin Lead Co. (Tucker 38:435,pl.3.)
	Darwin-Keystone						See Keystone. (Eric 48:242; Tucker 38:16; 38: 426,435-436,471,pl.3.)
114	Darwin Mines (Bernon, Columbia, Defiance, Driver, Essex, Independence, Lane, Liberty	Anaconda Copper Mining Co., William H. Hoover, pres., 25 Broadway, New	11, 12, 13, 14,	19S	40E	MD	Also tungsten and copper. (Chalfant 33:294; Hamilton 20:37; 22: 47; Kelley 38:503-562; Knopf 15:1-18; Newman 23:420; 23:30; Stewart 48:56; Tucker 38:426,436-437,pl.3; 41:567-

LEAD, SILVER, AND ZINC—CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
114	Darwin (Continued) Lucky Jim, Promontory Rip Van Winkle, South west, and Thompson)	York, N.Y.	23, 24, 25 30	19S	41E	proj. MD	568; 43:118; herein.)
	Death Valley	P.S. Noon, Los Angeles	--	21N	2E	SB	Two miles E of Wingate Pass Manganese deposit. Ore assays 13-14% lead.
115	Defense	L.D.Foreman and Wm. V. Skinner, Panamint Springs	28, 29	19S	42E	MD proj.	(Eric 48:242;herein.)
	Defiance						See Darwin. (Crawford 94:24; 96:32; Davidson 02:5,11; DeGroot 90:210-211; Eric 48:242; Goodyear 88:224-225; Jenkins 42:323; Kelley 38:555,557-558,pls.6,7; Knopf 15:13-14; Stewart 49:56; Tucker 21:285; 26:483; 38: 426-437,471,pl.3; 41:567-568; 43:118; Waring 19:94.)
	Denman	William Denman Box 674, Big Pine.	--	10S	36E	MD proj.	Argentiferous lead minerals with some gold. Worked by 2 shallow shafts, adit and open cut. Shipped 45 tons of ore early part 1950.
	Dennis Jr.						See Pierson Mining Co.
	Driver						See Darwin. (Davidson 02:5; Tucker 38:471.)
	Durham						See Fernando and St. Charles.
116	Ella	William Betts, Box 452, Clear Lake Highlands	13	16S	38E	MD proj.	(Eric 48:242; Tucker 26:483; 38:437,472,pl. 3.)
117	Empress	Sam L. Holcomb, Bakersfield and others	2	19S	41E	MD proj	Also copper. (Herein.)
	Essex						See Darwin. (Davidson 02:5; Davis 48: fig.2; Eric 48:242; Kelley 33:556-557,pls.6,7.) See also Big Silver.

LEAD, SILVER, AND ZINC--CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
118	Estelle and Morning Star (Riff Raff, Sure Contest, Troeger's Tunnel)	Estelle Mining Corp Walter Davis, pres., Roy L. Troeger, sec., 4600 Encino Ave., Encino	23, 24, 26	16S	38E	MD proj.	Also gold. (Eric 48:242; Knopf 14:110; 18: 116-117; Newman 23:421; Tucker 21:286; 24: 187-189; 26:483-484; 38:437-440,472,pls.3,4; Waring 19:108-109; herein.)
	Eureka						See Panamint. (Murphy 32:pl.5.)
	Fairbanks		11	19S	40E	MD	See Ruona. Fissure in tactite. Worked by 150-ft. shaft; (Kelley 38:pl.7; Tucker 38: 440,472,pl.3.)
119	Fernando and St. Charles (Durham, Fernando, Hayward and St. Charles)	C.W. Fletcher, Big Pine	24	19S	40E	MD	Also tungsten. (Kelley 38:560-561,pl.7; Tucker 26:484-485; 38:440,472,pl.3; 41:570-571; 43:118.)
	Franklin D. Roosevelt	J.W. Wightman, Lone Pine (1935)	approx	15S	37E	MD	(Eric 48:243.)
	Free and Easy	C.L. Evans, Los Angeles (1943)	approx	24N	3E	SB	(Eric 48:243.)
	Gibralter (Big Horn)						See Honolulu-Big Horn.
	Gladstone	C.Brown, Shoshone	approx	20N	5E	SB	(Eric 48:243.)
120	Gold Bottom (Copper Queen No.2, Slate Range, American)	Gold Bottom, A.L. Damon, pres., 2215 Poplar Ave., Sacramento	31	24S	44E	MD proj.	Also gold and copper. (Eric 48:241,244,251; Tucker 26:501; 38:17; 38:427,455,471,pl.3; 40:10,26; herein.)
121	Grand View	Chas. M. Heron, San Gabriel	1,2, 11,12	19S	41E	MD proj.	Argus Range. (Herein.)
122	Grandview	D.H. Tobias, 124 DeYoung Bldg., San Francisco	--	19S	40E	MD	Darwin district. (Tucker 38:473.)
123	Grand View	Panamint Mining Co.	4	21S	45E	MD proj.	Patented claim near Panamint City. (Murphy

LEAD, SILVER, AND ZINC--CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
123	Grand View (Continued)	(1932)					32:pl.5: Tucker 38:pl.3.)
	Grant						See Shoshone. (Hamilton 20:37; Hazzard 37:298; Sampson 33:267; Tucker 21:291-293; 26:491-492; 38:426,448-450,477,pl.3; Waring 19:103-104.)
	Gunsite						See Shoshone. (Burchard 84:166; Eric 48:245; Hamilton 20:37; Hazzard 37:298; Sampson 37:264-267; Tucker 21:286-287; 26:485; 38:426,440,473,pl.3; 43:120; Waring 19:95-96.)
	Hayward						See Fernando and St.Charles.Jenkins 42:323.)
	Hemlock Silver (Silver Peak						See Panamint. (Davidson 02:6; Murphy 29:86, 90,105-106; Sampson 32:362; Tucker 26:500; 38:451,473,477,pl.3.)
124	Homestake	Edith Lockhart, George Koest, Box 75, Darwin	approx 29, 30	18S	40E	MD	Replacement in dolomite. Worked by 50-ft. and 150-ft. vertical shafts and several hundred feet of drift. (Tucker 38:473.)
125	Honolulu-Big Horn (Gibralter)	John H. Thorndike, Trona	29 or 30	22S	45E	MD proj.	(Eric 48:245; Murphy 29:121; Sampson 32:361; Tucker 26:485; 38:440,472,pl.3; Waring 19:95; herein.)
	Hortense	Within U.S. Naval Ordnance Test Station, Inyokern	31	20S	40E	MD	(Tucker 38:473.)
	Hudson						See Big Silver.
	Hudson River						See Panamint. (Davidson 02:6; Tucker 38:473)
	Ibex (Arcturus)	John W. Rayburn, Ta-Neva-Ho, Crystal Bay, Nevada	--	19N	5E	SB	In San Bernardino County. See San Bernardino County reports. (Eric 48:238; Tucker 21:287; 38:473,pl.3; Waring 19:96-97.)
	Ida						See Panamint. (Davidson 02:6; Tucker 38:473,pl.3.)

LEAD, SILVER, AND ZINC

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Ignacio (Ygnacio, Saint Ignacio)						See Cerro Gordo. (Chalfant 33:282; Crawford 96:32; Davidson 02:6; Eric 48:245,253; Raymond 70:17; Tucker 21:287; 26:485; 38:442, 473,480,pl.3; Waring 19:97-98.)
	Independence						See Darwin. (Crawford 94:24; Davidson 02:6; DeGroot 90:210,211-212; Eric 48:245; Goodyear 88:226; Jenkins 42:323; Kelley 38:556, pls. 6,7; Knopf 15:14-15; Stewart 49:56; Tucker 21:287-288; 26:483,486-487; 38:16; 38:426,436-437,442,474,pl.3; 41:567-568; 43:118; Waring 19:98.)
126	Jackass	J.J. & Geo. F. Seman, 622 Sonora Ave., Glendale	13, 24	19S	40E	MD	Galena, chalcopyrite and pyrite in a bedding plane deposit in tactite. Worked by 140-ft. inclined shaft. (Davidson 02:6; Kelley 38:560,pl.7; Tucker 21:288; 26:487; 38:442,474, pl.3.)
	Jack Baxter						See Baxter.
	Jumbo	----	17	17S	39E	MD proj.	Irregular lenses in limestone worked by adits. Shipments in 1915 assayed 8% copper, 15% lead, 40 oz. silver. (Eric 48:246; Tucker 26:464; 38:pl.3; Waring 19:73.)
127	Kane	Belcher Extension Mining Co., Jersey City, N.J. (1938)	--	23S	43E	MD proj.	Galena and lead carbonate are in a series of parallel fissures in limestone which strike N 30° W and dip 30°-40° W. worked by a series of shallow adits, open cuts and shafts. (Tucker 26:487-488; 38:442,474,pl. 3.)
128	Kerdell	Gold Hill Dredging Co., 311 California St., San Francisco	approx	17S	43E	MD proj.	(Herein.)
129	Keystone (Darwin-Keystone, Silver Button and Shamrock)	Hilda Bickley, Helen Gunn, Jess G. Sutleff, Independence	24, 19	19S 19S	40E 41E	MD MD proj.	Oxidized lead minerals in replacement bodies in limestone. Worked by 2 adits. (Eric 48:246; Kelley 38:pl.7; Tucker 38:16,38:426,435 436,471,pl.3.)

LEAD, SILVER, AND LEAD--CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	King Henry	W.J. Lange, Brown (1942)	apprx	24S	47E	MD	(Eric 48:246.)
	Lane (Last Chance No. 2, Sorba)						See Darwin. (Butner 49:6,fig. 10; Crawford 94:24; 96:32; Davidson 02:6,11; Eric 48:246; Kelley 38:559-560,pl.3,Knopf 15:16; Tucker 21:288; 26:483,488; 38:442-443,475,pl.3; Waring 19:98-99.)
	Last Chance						See Lane and Darwin.
	Lead King						See Lippincott.
130	Lead (Hughes)	Mason E. Franklin, 4599 Pacific Blvd., Los Angeles	--	19S	42E	MD proj.	(Herein.)
131	Leary	Mrs. Margaret Loundigan, San Francisco, Mark Leary, Olancha, and associates	24?	16S	37E	MD proj.	Zinc-lead orebody, 4 ft. wide, assays 35% zinc, 8% lead and 8 oz. silver. Picked lead ore reported 30% to 40% lead. Worked by 150-ft. shaft. Operated in 1943 by Desert Miners, Lone Pine. (Eric 48:247.)
132	Lee (Emigrant)	Mrs. Agnes Reid, Panamint Springs	24, 26	17S	40E	MD	Ore is fracture fillings in limestones in a zone 1000 ft. long and 400 ft. wide. Worked by several shafts and open cuts. (Burchard 84:163; Eric 48:247; Tucker 21:289; 26:488; 38:443,475,pl.3; Waring 19:99-100.)
133	Le Moigne (LaMoine)	W.R. McCrea, Reno, Nevada (1938)	--	17S	43E	MD proj.	Irregular lenses of galena and lead carbonate occur in lenses along fissures in limestone; fissures strike N dip 65° W. (Tucker 26:488; 38:443,475,pl.3.)
	Leroy						See Bedell. (Newman 23:421.)
	Liberty						See Darwin. (Tucker 38:475.)
134	Lincoln (Silver Dome)	A.T.Wilkerson, et at, Bishop (1938)	--	6S	37E	MD	Silver ore in quartz veins cutting granite. Worked by shafts and adits. (Tucker 21:289; 26:488-489; 38:443-444,475,pl.3.)

LEAD, SILVER, AND ZINC--CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
135	Lippincott (Lead King)	George Lippincott, P.O. Box 1811, Santa Ana	13	15S	40E	MD proj.	(McAllister, 49; herein.)
136	Little Chief	Panamint Mining Co. (1932)	10, 15	21S	45E	MD proj.	Worked by shaft and adits. (Davidson 02:6; Murphy 32:pl.5; Tucker 38:475,pl.3.)
137	Long John	James A. Walker, 1201 N. Isabel St. Glendale	16, 21	15S	37E	MD proj.	Galena and cerussite in fissure in limestone Reported production 1925-1926 of $60,000. Grade of ore shipped 40% lead and 40 oz. of silver. Worked by shafts and adits. (Eric 48:247; Tucker 38:444,475,pl.3; 40:10,26.)
	Lucky Jim						See Darwin. (Chalfant 33:294; Crawford 94:24; Davidson 02:6; DeGroot 90:211-212; Eric 48:247; Goodyear 88:226; Kelley 38:554,pl.7; Knopf 15:12-13; Tucker 21:289-290; 20:189; 26:483,488-489; 38:426,444,475; Waring 19:100-101.)
	Mabel						See Noonday and Shoshone. (Tucker 38:475.)
138	March Storm	Western Lead Mines Co., Los Angeles (1926)	33, 34	12S	45E	MD	Argentiferous galena is disseminated in limestone also in scattered lenses along bedding planes. Worked by numerous adits. (Tucker 26:509-510; 38:475.)
			10, 11	13S	45E	MD	
	Marvel						See Panamint. (Sampson 32:361-364; Tucker 21:280-281; 26:495; 38:451,475,pl.3.)
139	Mexican (Reed Flat)	Jim Burchim and Frank Watkins, Bishop, H.M. Brown, Big Pine	6	7S	35E	MD	(Tucker 26:497; 38:452,478,pl.3; herein.)
140	Midnight (Blue Dick)	Ed Grimshaw, Pat McLaughlin, Frank McQueary, Tecopa	--	20N	10E	SB proj.	Fissure filling in limestone. Worked by adits. (Eric 48:239; Sampson 37:264; Tucker 21:283; 26:479; 38:429,469,pl.3; Waring 19:89.)

LEAD, SILVER, AND ZINC--CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
141	Mineral Hill (Swank)	R.W. Swank, et al, Big Pine (1938)	29	8S	36E	MD	Irregular lenses of galena and cerussite in series of parallel veins in limestone and tactite. Worked by adits. (Eric 48:252; Tucker 26:489; 38:444,476,pl.3.)
	Mineral Point						See Black Canyon.
142	Minnietta (Minneatta, St. John)	Mrs. Jack Gunn, Independence	33, 34	19S	42E	MD proj.	(Davidson 02:8; DeGroot 90:212; Eric 48:248; Tucker 21:200; 26:490; 38:426-427,445,476, fig. 9, pl.3; Waring 19:101; herein.)
143	Modoc (Modock)	Hearst Estate, San Francisco	27, 28	19S	42E	MD proj.	(Burchard 84:164; 85:104; Crawford 94:24; 96:32; Davidson 02:7,11; Eric 48:248; 21:290; 26:490; 38:426-427,445,447,476,fig.9, pl.3; Waring 19:101; herein.)
144	Monster (Blue Monster)	Dr. John MacLean Estate, 412 E. Manchester Ave., Inglewood	8	14S	38E	MD proj.	Lenses of galena associated with quartz in limestone. Worked by adits and open cuts. 50 tons shipped in 1935 reported to assay $100 per ton in lead and silver. (Eric 48:248; Knopf 14:111; 18:117-118; Tucker 21:290; 26:490; 38:426,447,476,pl.3; Waring 19:101.)
145	Monte Carlo (Mount Whitney-Union)	James M. Johnson, Sr. and James M. Johnson, Jr., 1505 N. Niagara Burbank	14	14S	36E	MD proj.	Galena with gold and silver in quartz vein cutting limestone and calcareous slate. Width of vein from 6 to 20 ft. Strikes N 70° E, dips 60° to 65° W. Has 8 adits, total workings 3000 ft. (Davidson 02:8; Eric 48:239,248,252; Tucker 26:501-503; 34:311; 38:457,469,476,479; Waring 19:84.)
146	**Montezuma**	Stuart Bedell, Big Pine, leased to Hugh Higham, Big Pine	7	10S	35E	MD proj	Galena and cerussite with gold and silver associated with sphalerite in lenses along fault in limestone and clay shales. Four cars of ore shipped by Eugene Craft, Big Pine, reported to assay 15% lead, 15% zinc, 100 oz. silver and $4 - $5 in gold. (Burchard 84:158; Crawford 96:32-33; Eric 48:248; Knopf 14:109-110; 18:116; Tucker 21:291 26:491; 38:426,447,476,pl.3; Waring 19:101

LEAD, SILVER, AND ZINC--CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Morman						See Cerro Gordo. (Tucker 38:476.)
147	Morning Glory	H.P. Gower, 510 W. 6th St., Los Angeles	2?	19S	45E	MD proj.	Also copper. Four claims 1 mile SW of Old Dependable. A 6-in. to 4-ft. quartz vein in shale. Reported to have shipped 3 cars of ore assaying $70. to $160 per ton several years ago. Reopening property in April 1950.
	Morning Star						See Estelle and Morning Star. (Eric 48:248; Tucker 20:188-189; 26:484; 38:439-440,pls. 3,4.)
	Mt. Whitney						See Union.
	New Deal	Lead Canyon Mining Co., Pacific Palisades (1941)	--	23S	44E	MD	
	New Enterprise	Thomas Henning	--	16S	38E	MD proj.	(Davidson 02:7; Tucker 38:477,pl.3.)
	Newsboy	Cerro Gordo Mining Co. (1918)	19	16S	39E	MD proj.	Galena, cerussite and bindheimite rich in gold and silver in quartz vein. Worked by adit. (Eric 48:249; Knopf 18:117.)
148	New Sutherland Divide Mining Co. (Carbonate and Queen of Sheba, also Carbonate, Ajax	New Sutherland Divide Mining Co., Henry Grim, sec., 403 W.8th St., Los. Angeles	--	22N	1E	SB proj.	(Eric 48:239; Newman 23:30; Tucker 24:33; 26:480; 38:430-431,470,pl.3; Waring 19:89-90; herein.)
	Noonday						See Shoshone. (Eric 48:245,249; Hamilton 20:37; Hazzard 37:298; Sampson 37:267; Tucker 21:291-293; 26:491-492; 38:426,448-450,477, pl.3; 43:120; Waring 19:103-104.)
149	Nopah	J.P. Madison, Shoshone	5	23N	8E	SB proj.	(Herein.)
	North Star	D.E. Boelter, et al Los Angeles, (1938)	--	15S	38E	MD proj.	Galena, pyrite and chalcopyrite with gold and silver in parallel quartz veins in gran-

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	North Star (Continued)						ite. Worked by shallow shafts and open cuts. (Tucker 38:413,477,pl.3.)
	Old Coso	Within U.S. Naval Ordnance Test Station, Inyokern	approx	20S	40E	MD	(Eric 48:249.)
	Old Gold	Old Gold Mines Co., Trona (1941)	approx.	22S	45E	MD	(Eric 48:249.)
150	Old Timer	Charles Meyson and E.F. Fitzgerald, Lone Pine, Julia Overgard, Oakland	29	17S	39E	MD proj.	(Herein.)
	Omega						See Cerro Gordo. (Tucker 38:477.)
151	Ophir (Uncle Sam)	Gold Bottom Mines, Inc., A.L. Damon, pres., 2215 Poplar Ave., Sacramento	24	24S	43E	MD proj.	(Eric 48:249; Tucker 26:492,493; 38:427,450, 459,pl.3; 40:10; Waring 19:105; herein.)
	Oro Fino						See Shoshone. (Tucker 38:477,pl.3.)
152	Paddy Pride (Paddy's Pride)	J.F. Duling, 108 W. 6th St., Los Angeles, and C.W. Walker, Lordsburg, New Mexico	--	20N	5E	SB proj.	Replacement in limestone. Worked by adits and open cuts. (Eric 48:249; Newman 23:611; Tucker 21:293; 26:493-494; 38:450-451,477, pl.3.)
	Pagan						See Cerro Gordo. (Tucker 38:477.)
	Panamint	F. Gray, Trona (1940)	--	19S	44E	MD proj.	Silver mine. (Eric 48:249; Tucker 38:477.)
153	Panamint Mines (Alabama, Challenge, Comstock, East Hemlock, Eureka, Hemlock, High Silver, Hudson River, Ida, Independence,	Hedvig Meyers, 6827 Haywood St., Tujunga	10, 11, 15, 21, 22	21S	45E	MD proj.	(Chalfant 33:285-292; Murphy 29:32; Sampson 32:361-364; Tucker 20:280-281 26:495,500 (Silver Peak Mine) 38:451,477; herein.)

LEAD, SILVER, AND ZINC--CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Panamint Mines (Continued) Marvel, Panamint Central, Stewart's Wonder, Star, and Wyoming.)						
154	Pennsylvania	J. Carruthers (1942)	13	16S	37E	MD proj.	Galena and cerussite in fissure in limestone Worked by shafts and adits. (Eric 48:249; Tucker 21:293; 26:495; 38:451,477,pl.3.)
155	Perry	Mrs. Agnes Reid, Panamint Springs	approx 30	17S	42E	MD proj.	(Herein.)
	Perseverance						See San Lucas.
156	Pete Smith	Wm. Skinner, et al, Lone Pine (1938)	—	17S	39E	MD proj.	Galena and cerussite in replacement orebodies in limestone. Worked by inclined shaft on 3 levels. (Tucker 26:485-496; 38:451,477,pl.3.)
157	Pierson Mining Company (Republic Whiteside)	F.W. Finger and C. T. Pierson, 229 Haldeman Ave., Louisville, Kentucky	5	13S	36E	MD	Irregular lenses of galena and cerussite in limestone. Worked by 3000-ft. crosscut adit and 50-ft. shaft. (Tucker 26:496; 38:451, 477,pl.3.)
	Pine Tree	Harvey Searing, Trona, (1938)	—	22S	45E	MD proj.	Galena and cerussite in limestone. (Tucker 26:496; 38:477.)
158	Professor	P.E. Day, Independence	30	12S	36E	MD proj.	Old mine name unknown. Galena in vein. Worked by 2 adits, one with 1000 ft. of workings.
	Promontory						See Darwin Mines. (Butner 49:5,fig.5; Eric 48:250; Kelley 38:561,pl.7; Tucker 26:496; 38:451,477; Waring 19:105-106.)
	Queen of Sheba						See New Sutherland Divide Mining Co.
	Rainbow						See Shoshone. (Tucker 38:477,pl.3.)

LEAD, SILVER, AND ZINC--CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
159	Raven	Archie Farrington Estate, Bishop, (1938)	--	15S	40E	MD proj.	Galena and lead carbonate orebodies in limestone. (Tucker 21:293; 26:496; 38:451,478, pl.3; Waring 19:106.)
	Red Cloud	Harry Briggs, Trona	--	23S	45E	MD proj.	(Herein.)
160	Red Dog	W.G. and W.J. Osborne, Panamint Springs	16	19S	42E	MD proj.	Vein in granite. Worked by trench and shallow shaft.
(161)	Red Eagle (Blue Bird)	Miss Louise Grantham, 809 E. 6th St., Ontario	--	22S	47E	MD proj.	(Herein.)
	Red Wing	R.J. Fairbanks, Shoshone, (1938)	--	22N	7E	SB	Lead and zinc carbonate in dolomite. Worked by 90-ft. inclined shaft. (Hazard 37:298; Sampson 37:268; Tucker 26:497; 38:452,478, pl.3; Waring 19:106.)
	Reed Flat						See Mexican.
	Reno						See Richardson
	Republic						See Pierson Mining Company. (Tucker 38:478.)
	Reward (Brown Monster)						See under Gold.
162	Richardson	C.W. Fletcher, Big Pine	13, 24, 18,	19S	40E	MD	Also gold. (Davidson 02:7; Tucker 38:478.)
			19	19S	41E	MD proj.	
	Riff Raff						See Estelle and Morning Star. (Eric 48:250.)
163	Rio Tinto Consolidated (Rio Tinto)	C.W. Fletcher, W.A. Sanger, Ralph Munger, c/o W.A. Sanger, 4431-8th Ave., Los Angeles	24	19S	40E	MD	(Tucker 38:478,pl.3.)

LEAD, SILVER, AND ZINC--CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Rip Van Winkle						See Darwin. (Kelley 38:548,pls. 6,7; Knopf 15:17; Tucker 21:294; 38:pl.3.)
	Rob Roy (Ibex)						See Ibex. In San Bernardino County. See San Bernardino County reports.
	Rose and Galena	J. Cyty, Beatty, Nevada (1939)	approx.	30N	1E	SB	(Eric 48:250.)
164	Royal (Cerro Gordo Extension, Spear)	Silver Spear Mining Corporation, George Merritt, pres., Santa Barbara	11, 12, 13, 14	16S	38E	MD proj	Also gold. (Eric 48:250; Tucker 21:294; 497-498; 38:433-434,470,478,pls. 3,4; Waring 19:106-107; herein.)
165	Ruona (Fairbanks, Santa Ana, Standard)	Mrs. Marie Wilson, 107 Meadowbrook Dr. San Francisco	11, 13, 14	19S	40E	MD	(Kelly 38:555,559,pl.7; Tucker 38:472,478, 479.)
	Sam Lucas						See San Lucas.
	San Lucas (Sam Lucas, Perseverance)	J. Brennan, Keeler, (1947)	18	16S	39E	MD proj.	Also copper and gold. Vein in limestone. Worked by adits. (Eric 48:249; Knopf 18:117; Tucker 26:498; 38:452,pl.3.)
	San Pedro	W.A. Coulter, San Pedro (1938)	--	9S	37E	MD	Galena in quartz vein in limestone. Worked by shafts and adits. (Tucker 26:498; 38:452,478,pl.3.)
	San Rafael	----	5	20S	45E	MD	Quartz vein on contact of schist and granitic rock; reported to assay 21% lead, 7% copper, and 4 oz. silver per ton. (Eric 48:250; Sampson 32:359; Tucker 26:465; 38:pl.3; Waring 19:74.)
	Santa Ana (Santa Anna)		13	19S	40E	MD	See Ruona Group. Fissure in limestone. Worked by 200-ft. shaft on 3 levels. (Kelley 38:559,pl.7; Tucker 38:452,478,pl.3.)
	Santa Maria						See Cerro Gordo. (Chalfant 33:281; Knopf 14:97; 18:108; Tucker 38:478; Waring 19:90.)

LEAD, SILVER, AND ZINC--CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
167	Santa Rosa	Santa Rosa Mining Co., c/o J.R.LeCyr, Keeler	26, 35	17S	39E	MD proj.	(Eric 48:251; Tucker 21:294; 24:189; 26:498-499; 38:452-454,478,pl.3; herein.)
168	Shoshone Mines (Alexander, Apex Consolidated Group, Black Prince, Columbia No.2, Grant, Gunsight, Mabel, Noonday, Oro Fino, Rainbow and War Eagle)	Ananoonda Copper Mining Company, W. H. Hoover, pres., 25 Broadwav, New York 4, N.Y.	-- 9, 10, 14, 15, 16, 22, 23, 27	19N 20N	8E 8E	SB SB proj.	(Hamilton 20:37; Newman 23:611; 23:30; Sampson 37:264-267,268-269; Tucker 21:286-287, 291-293; 26:485,491-492,503-504; 38:426,440-442,448-450,458; 43:120; Waring 19:95-96,103 104; herein.)
	Silver Button and Shamrock						See Keystone. (Tucker 26:499-500; 38:454, 478.)
	Silver Dome						See Lincoln.
	Silver King	----	8	24S	43E	MD	Galena and cerussite in a vein in limestone. Worked by adit. (Tucker 26:500; 38:455,pl. 3.)
	Silver Peak - Hemlock						See Panamint.
	Silver Reef						See Ventura.
	Silver Rule	John Prato, Fontana (1943)	--	19N	10E	SB proj.	In San Bernardino County. See San Bernardino County reports, also (Eric 48:251; Hazzard 37:298; Sampson 37:268; Tucker 26: 500; 38:455,479, pl.3; Waring 19:108.)
	Silver Saddle (Gray Eagle)	Leo V. Howell, 1534 N. Curson, Hollywood (1950)	approx	19S	45E	MD proj.	Property reopened in 1949-50.
	Silver Spear Mining Co.						See Royal.
169	Silver Spoon	Theodore Peterson, Darwin	25 30	19S 19S	40E 41E	MD MD proj.	(Kelley 38:561,pl.7; Tucker 26:500-501; 38: 455,479,pl.3; herein.)

LEAD, SILVER, AND ZINC--CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Slate Range						See Gold Bottom.
	Sorba						See Lane and Darwin.
	Southwest						See Darwin. (Tucker 38:479, pl.3.)
	Spear						See Royal. (Eric 48:251; Tucker 21:294; Waring 19:106-107.)
	Standard	----	13, 14	19S	40E	MD	See Ruona. Fissures in limestone and tactite. Worked by adits and open cuts. (Kelley 38:559,pl.7; Tucker 38:455,479,pl.3.)
	Star						See Panamint. (Tucker 38:479,pl.3.)
170	Sterling	Sterling Mining Co., Trona (1938)	--	20S	42E	MD proj.	A 4 to 6-ft. quartz vein strikes N. 10° E, dip 60° E along a quartz monzonite-limestone contact. Worked by 2 shafts, 285 ft. and 120 ft. deep, and related drifts and stopes, (1938). Ore minerals consist of argentite and silver bromide, assaying $8.00 to $15.00 in silver. (Tucker 38:17; 38:456,479,pl.3.)
	Stewart's Wonder (Panamint)						See Panamint. (Davidson 02:8; Jenkins 42:324; Murphy 29:104-105; Sampson 32:363; Tucker 21:280-281; 26:495; 38:451,479,pl.3.)
	Summit No. 2						See Cerro Gordo. (Davidson 02:8; Tucker 38:479,pl.3.)
	Sure Contest						See Estelle and Morning Star. (Eric 48:251.)
171	Surprise	A.L. Foss, J.L. Osborne Estate, Panamint Springs	approx 20	19S	42E	MD proj.	(Herein.)
172	Susquehanna	Mickey Summers, Darwin. Leased to Darwin Lead Consolidated Mining Co.,	23, 24	19S	40E	MD	Fissure trending NE in Pennsylvanian limestone and tactite near quartz diorite stock. Worked by 50-ft. shaft and 700-ft. of drift. (Kelley 38:pl.7.)

LEAD, SILVER, AND ZINC--CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
172	Susquehanna (Continued)	8350 W. 3rd St., Los Angeles					
	Swank (Mineral Hill)						See Mineral Hill.
	Swansea	----	--	16S	38E	MD proj.	Lead and zinc minerals along contact of limestone and quartzite. Worked by 70-ft. inclined shaft and drifts. (Tucker 26:501; 38:456,pl.3.)
	Swansea Chief	-----	----	16S	38E	MD	Galena and cerussite in fissures in limestone. Worked by 2 shafts 150 ft. deep. (Tucker 21:294; 26:501; 38:456,pl.3.)
173	Sylvia	Pete and Fritz Miller, Trona	5?	20S	44E	MD proj.	Also gold. Worked by 60-ft. inclined shaft and 2 adits.
	Thompson						See Darwin. (Eric 48:252; Jenkins 42:323; Kelley 38:557,pl.3; Stewart 48:56; Tucker 26:483,486-487; 38:436-437; 41:567-568; 43:118.)
174	Ubehebe	Ubehebe Lead Mines, Inc., 356 S. Spring St., Los Angeles, (Grant Snyder and C.A. Rankin). Under lease to Henry Hageman, Beatty, Nevada	1	14S	40E	MD proj.	(Eric 48:252; Tucker 21:294; 26:501; 38:456,479,pl.3. Waring 19:109-110; herein.)
	Uncle Sam						See Ophir. (Tucker 38:479,pl.3.)
	Union (Big Wedge, Monte Carlo, Mount Whitney-Union)						See Monte Carlo. (Chalfant, 33:139,140; Davidson 02:8; Goodyear 88:262,264; Tucker 26:501-503; 38:457,479; Waring 19:84)

LEAD, SILVER, AND ZINC—CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Union						See Cerro Gordo. (Crawford 94:24-25; 96:32; Davidson 02:8,11; DeGroot 90:213-214; Knopf 14:97; 18:108; Tucker 20:33.)
	Utacala						See Zinc Hill. (Tucker 21:294-295; 26:503; 38:458,479,pl.3; 43:120.)
175	Ventura (Silver Reef)	Mrs. Ethel Thompson, Route 3, Box 1015, Yucaipa	23	16S	38E	MD proj.	Davidson 02:8; Eric 48:251,252; Knopf 18:117; Tucker 21:295; 26:503; 38:426,458,479 pls. 3,4; Waring 19:110-111; herein.)
	Wallace	Within U.S. Naval Ordnance Test Station, Inyokern	approx	20S	40E	MD	(Eric 48:253.)
	Warbaby and Ark	D. Roe, Lone Pine (1941)	approx	19S	38E	MD	(Eric 48:253.)
	War Eagle						See Shoshone. (Sampson 37:268-269; Tucker 26:503-504; 38:426,458,480,pl.3.)
	Warren	W. Lucht and Benjamin Stocton, Big Pine (1947)	15	11S	36E	MD proj.	(Eric 48:253.)
176	Westgard (Chalmers)	Westgard Consolidated Mining Co., Big Pine (1941)	14	7S	35E	MD	Galena and cerussite in fissure along contact between limestone and quartz-diorite. Worked by shafts and adits. (Eric 48:253; Tucker 21:284; 26:482; 38:458-459, 480,pl.3.)
	Wingate Pass	Howard L. Rogers, 958 S. Blaine St., Los Angeles (1942)	--	21N	2E	SB proj.	Two miles east of Wingate Pass manganese deposit. 80-ft. shaft in lead-molybdate ore assaying 13-20% lead, 5-20% MoS_2.
177	Wonder (Wallace Wonder)	Richard Wallace, Darwin	13	19S	40E	MD	Lead and copper carbonates in calcite vein along bedding in tactite. Worked by adits and shaft. (Eric 48:253; Kelley 38:559; pl. 7; Knopf 15:16-17; Tucker 26:465,504; 38:459,480,pl.3.)

LEAD, SILVER, AND ZINC--CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Wyoming						See Panamint. (Davidson 02:8; Murphy 29:98-103; Sampson 32:363-364; Tucker 26:495; 38:451,477,pl.3.)
	Ygnacio						See Ignacio and Cerro Gordo.
178	Zinc Hill (Utacala, Colorado)	Combined Metals Reduction Co., 218 Felt Bldg., Salt Lake City, Utah	35 or 2	18S 19S	41E 41E	MD proj. MD proj.	(Eric 48:240,252,253; Tucker 21:294-295; 26:503; 38:458,470,479,pl.3; 43:120; herein.)

MANGANESE

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
179	April Fool (Keegan)	Thos. Keegan, J.D. Gray, and Ed Miley	33	21N	2E	SB proj.	Porous, tuffaceous bog manganese ore in conglomerate. Ore in place assays 32.2% Mn, 30.2% insoluble. (Trask 43:121; 50:80.)
	Black Dream						See Wingate Wash.
	Caffee	C.E. Caffee	approx 25	18S	36E	MD proj.	Wad in sediments adjacent to granite.
	Campbell	W.D. Campbell	--	--	--	--	In "Death Valley" (Trask 43:121; 50:81.)
	Connard Bros.	Connard Bros.	--	--	--	--	"Thirty-two miles west of Zabriskie". (Bradley 18:36; Trask 43:121; 50:81)
	Death Valley (Manganese Nos. 1 to 6)	E.P. Underwood, E.G. Henderson	--	--	--	--	"Stringers of manganese oxide cut rhyolite and andesitic breccia." (Bradley 18:36; Trask 43:212; 50:81-82.)
	Geronimo	Ben Grier	--	19S	38E	MD	"Small amount of manganese oxide in lava." (Trask 43:121; 50:82.)
	Keegan						See April Fool.
	Lillie (Mature Consolidated)	Mrs. Gertrude Morgan	14, 15, 20, 21	23S	43E	MD	"Gossan in limestone; manganese oxide from gedrite and garnet rock." (Trask 43:121; 50:82-83.)
180	Manganese Nos. 1 and 4	Thos. Keegan, J.D. Gray, Ed Miley	33	21N	2E	SB proj.	"Fissure deposit". (Trask 43:121; 50:83.)
	Manganese Nos. 1 to 6						See Death Valley.
181	Manganite	Arthur R. Cassidy 220 E. 19th St., Bakersfield, Catherine E. and Sarah Williams	28, 33	21N	2E	SB proj.	(Herein.)
	Mature Consolidated						See Lillie.

MANGANESE--CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Orr	Frank W. Orr	--	--	--	--	"40 miles from Shoshone. Bedded deposit?" (Trask 43:122; 50:83.)
	Runge	Chris Runge	--	18S	38E	MD	(Trask 43:122; 50:83.)
182	Saline Valley	P.I. Dolley, Pacific Alkali Co., Lone Pine (1941)	9	13S	39E	MD	Bedded deposit of manganese mixed with calcite and overlain by limestone breccia and wash material. Assays 20-30% Mn and 0.24-0.63% WO_3. Tungsten probably in manganese as absorbed tungstic acid.
	War Baby (Wingate Wash	W.C. Davis, G. Fleharty, Jr.	--	20N	1E	SB	"Probable location". Manganese oxide occurs as bedded deposit in conglomerate and sandstone. (Trask 43:84,122; 50:83)
	White Mountains	Guy Way, Bishop (1942)	--	7S	35E	MD	17 miles NE of Big Pine. Grab samples assayed 50% Mn, 2% SiO_2.
	Wingate Wash						See War Baby.
183	Wingate Wash (Black Dream)	Roy C. Troeger, 4600 Encino Ave., Encino	--	20N	1 or 2E	SB proj.	(Trask 43:121; 50:81; herein.)

MOLYBDENUM

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
184	Coso Molybdenite	H.A. Clark et al., Darwin (1938)	7?	20S	38E	MD proj	Molybdenite disseminated in seams and in joints in a granitic stock; average assays 0.35% MoS_2. (Tucker 38:459,471,pl.3.)
	De Soto						See Coso Molybdenite
	Molybdenite						See Coso Molybdenite
	Pine Creek						See under Tungsten
	Wingate Pass						See under Lead

QUICKSILVER

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Coso Quicksilver	Within U.S. Naval Ordnance Test Station, Inyokern	5-8	22S	39E	MD	(Dupuy 48;Fraser 42:242; Ransome 39:378-380; Ross 43; Tucker 38:460-462,471,pl.3; 40:10, 26-27; Warner 30:58-63; herein.)

TUNGSTEN

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
185	Adamson (Panaminas Co)	D.P. Adamson, Bishop	29, 30	6S	30E	MD proj.	(Bateman 45:231-249,pls. 36,47; Jenkins 42:317; Lemmon 41:91-92,pl.14; Partridge 41:292; Tucker 38:462,468,pl.3; 43:119-120; herein.)
186	Aeroplane (Mesa, Moonlight, Standard, Tungsten City Milling Company)		13	7S	31E	MD	Scheelite in tactite. Glory hole, adits and inclined shaft. Production through 1945 totals 16,000 units of WO_3 from 51,000 tons of ore. (Bateman 50:35-36,pls.7,9; Hess 21:270-271; Jenkins 42:319; Knopf 17:230,243-245; Lemmon 41:507-509,pl.73; Partridge 41:299; Tucker 21:303-304; 26:512; 38:464,467; 40:27,28; Waring 19:129-131.)
	Alvord	Wm. Elliot, Ray Spear, Rose Spear (1916)	20, 21	15S	41E	MD proj.	Scheelite in tactite. No production. (Jenkins 42:322; Partridge 41:310; Waring 19:131.)
187	Bakoch	Nick Bakoch, John Somerville, Big Pine	approx 27	9S	33E	MD	Herein
	Beverly	Within U.S. Naval Ordnance Test Station, Inyokern	8	20S	40E	MD	(Jenkins 42:323.)
	Big Sister						See Little Sister. (Tucker 28:469.)
188	Bishop Concentrate and Cleaning Co. (Bishop Tungsten Mines Mill,	G.E. Benware, Bishop.	7	8S	33E	MD	Partridge 41:293; Tucker 38:463; 40:27; 43:118; herein.)
	Bishop Tungsten Company						See Rossi mine and Bishop Concentrate and Cleaning Company. (Partridge 41:292-293; Tucker 38:462-463,pl.3; 40:27; 43:118.)
	Black Monster	M. Rossi and William Skinner, Big Pine, Calif. and R. J. F. Brackett, Bishop	approx 36	8S	31E	MD	Scheelite in tactite and extending into diorite at contact with limestone. Worked by open cut and incline. (Tucker 43:59-60.)

TUNGSTEN--CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Boyd and Welch	----	8	7S	32E	MD	Scheelite in Tactite. (Jenkins 42:320; Knopf 17:230; Partridge 41:293.)
189	Brownstone (Brown stone Nos. 1 and 2)	El Diablo Mining Co., Bishop	8	7S	30E	MD proj.	Scheelite in tactite. (Jenkins 42:318.)
	Bruce (Wonder)	R.W. Wallace, Darwin	13	19S	40E	MD	Scheelite in tactite. (Jenkins 42:323; Kelley 38:559.)
	Buckshot (Shannon Creek)	----	20	8S	33E	MD	Scheelite in tactite. Prospected only by shallow pits. (Jenkins 42:321; Knopf 17:248-249; Partridge 41:298; Waring 19:131.)
	Crawford						See Tungstar
	Darwin	Anaconda Copper Mining Co., 25 Broadway, New York, N.Y.	13, 23, 25	19S	40E	MD	See also under lead-silver-zinc. Scheelite and stolzite in the lead orebodies. (Jenkins 42:323; Tucker 41:567-568.)
190	Division Creek	J.L. McCullough, Independence and others	approx 35	11S	33E	MD proj.	(Jenkins 42:322; Tucker 41:568-569; herein.)
	Division Creek-Apex	G.L. Lund, Los Angeles, W.J. Thompson, Independence	33, 34, ?	11S	33E	MD proj.	Scheelite in tactite. Leased in 1942 for exploration by Nevada-Massachusetts Co., Lovelock, Nevada. Worked by open cuts and trenches.
	El Diablo Mining Company	El Diablo Mining Company, H.O. Johanson, Bishop	11, 12, 13	7S	31E	MD	See Jack Rabbit, Little Sister and Lucky Strike. Mill operation under Round Valley. See text. (Jenkins 42:319; Partridge 41:294-295; Tucker 38:18; 38:464,472,pl.3; 40:10,27)
	Emergency	D.F. Shively, W.A. Singer, Stuart Bedell.	4	7S	36E	MD	Scheelite in quartz vein in limestone near granite contact. (Jenkins 42:320; Partridge 41:311; Tucker 21:301; 26:511; 38:464,472, pl.3.)

TUNGSTEN--CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Feldman	Within U.S. Naval Ordnance Test Station, Inyokern ?	16?	23S	38E	MD	Scheelite in quartz vein; reported 1-5% WO_3. (Jenkins 42:324; Partridge 41:311; Tucker 38:464,pl.3.)
	Fernando and St. Charles (Durham, Fernando Hayward and St. Charles)	C.W. Fletcher, Big Pine	24	19S	40E	MD	See also under lead-silver. (Butner 49:2-3, 5,6,fig. 7; Jenkins 42:323; Partridge 41:310; Tucker 41:570-571,574-575; 43:119; Wilson 43:543-560.
191	Hanging Valley (J. and M. Millovich)	Juno Millovich, Bishop, and Fred R. Lee and J. W. Wilhoit, San Diego	approx 22	7S	30E	MD proj.	(Jenkins 42:318; Lemmon 41:94-95,pl.14; herein.)
	Hilltop	----	8	7S	32E	MD	Scheelite in tactite. Worked by adits and glory hole. Some production in 1943. (Bateman 50:38,pl.7.)
	Huntley Industrial Minerals, Inc. (Tungsten City Milling Co.)	Huntley Industrial Minerals, Inc., Box 305, Bishop	13	7S	31E	MD	Also garnet. See Aeroplane. (herein.)
192	Jack Rabbit	El Diablo Mining Co., Bishop (1942)	12	7S	31E	MD	Scheelite in tactite. Worked by 200-ft. adit and 3 glory holes. Estimated production 2000-3000 tons of ore grade 0.2 to 0.7% WO_3. Last operated 1943-1944. (Bateman 40:36,pls. 7,10; Hess 21:272; Knopf 17:230,245-246; Lemmon 41:509,pl.73; Partridge 41:294-295.)
193	Jumbo	J.W. Thompson, Independence, and G. E. Lund, Jr., Los Angeles (1942)	15	13S	36E	MD proj.	Also gold. (Davidson 02:6; Jenkins 42:322; Tucker 26:469-470; 38:402,474,pl.3; 41:569; herein.)
	Keogh	Within U.S. Naval Ordnance Test Station, Inyokern	23?	20S	40E	MD	Scheelite in tactite; worked by open cuts. (Jenkins 42:324; Tucker 41:569.)
194	Lakeview (Carpenter and Brown)	George Brown and Kenneth Irons, Bishop	21	7S	30E	MD proj.	(Jenkins 42:318; Lemmon 41:95,pl.14; Tucker 43:119; herein.)

TUNGSTEN--CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
195	Lambert	Stanley Lambert (1942)	11	7S	30E	MD	(Jenkins 42:318; herein.)
	Last Rose						See Waucoba.
	Little McGee Creek	McClosky Mines, Inc 148 S. Beverly Dr., Beverly Hills	13	7S	31E	MD	Scheelite in tactite. Worked by 135-ft. adit. (Jenkins 42:320; Tucker 41:570.)
196	Little Shot (Brooks)	G.Crawford and associates, Bishop	35	6S	31E	MD proj.	(Bateman 50:42,fig. 3; herein.)
197	Little Sister (Tungsten Mines Company)	El Diablo Mining Co Bishop (1942)	12, 13	7S	31E	MD	(Bateman 50:34-35, pls. 7,8; Hess 21:271-272; Jenkins 42:319; Knopf 17:230,245-246; Lemmon 41:509-510, pls. 73,75; Partridge 41:94-95; Tucker 21:304-305; 26:512; Waring 19:133; herein.)
198	Lucky Strike	El Diablo Mining Co. Bishop (1942)	11	7S	31E	MD	Scheelite in tactite. Worked by glory hole and 2 adits. (Bateman 50:34, pl.7; Lemmon 41:510 pls.73,76.)
	MacVan	MacVan	2	8S	32E	MD proj.	Scheelite in very small tactite bodies. (Jenkins 42:321; Knopf 17:230,248; Partridge 41:295.)
199	Marble (Shannon Creek)	A.H. Peterson, John Utter estate, Bishop	31	8S	33E	MD	Not to be confused with Buckshot (Jenkins 42:321; Tucker 38:467,478,pl.3; herein.)
	Molly Tungstite	F.L. Murphree, A.L. Covington (1942)	8	7S	30E	MD proj.	Scheelite in tactite. (Jenkins 42:318.)
200	Monarch	Monarch Tungsten Co. (1915)	31	15S	41	MD proj.	Hubnerite in vein in granite. Worked by 50-ft. shaft. (Jenkins 42:322; Partridge 41:311-312; Waring 19:131.)
	Moonlight (Moonlight 1,2,5,6)	Gilbert W. Smith, 243 E. Colorado St. Pasadena	--	7S	31E	MD	Scheelite in tactite.
	Mt. Tom						See Tungstar.

TUNGSTEN—CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Mountain Kid	Within U.S. Naval Ordnance Test Station, Inyokern	19	20S	40E	MD	Scheelite in tactite. Worked by shaft. (Jenkins 42:324; Tucker 41:570.)
	Noble (Nobles Camp)						See Round Valley. (Knopf 17:230,247.)
	Pacific Tungsten Company						See Fernando and St. Charles . (Tucker) 41:570-571; 43:119.)
	Panyo	Within U.S. Naval Ordnance Test Station, Inyokern	14	20S	40E	MD	Scheelite and powellite in tactite; zone 6-10 ft. wide, strikes east and dips 45° S. Open cuts and 2 adits. Shipped 160 tons ore. (Jenkins 42:323; Tucker 41:571-572.)
201	Pickup (Chipmunk)	Tungsten Consolidated, N.C. Aldo, Hollywood (1942)	33	7S	32E	MD proj.	Scheelite in tactite. (Jenkins 42:320; Knopf 17:230,247-248; Lemmon 41:100-102, pl.14; Partridge 41:293-294.
202	Pine Creek	United States Vanasium Corp., 30 E. 42nd St., New York 17, N.Y.	30, 31 19, 20	6S 6S	30E 31E	MD proj. MD proj.	Also molybdenum, copper, gold and silver. (Bateman 45:231-249,pls.36-46; Eric 48: 249; Hess 21:274-276; Jenkins 42:317; Knopf 18:124; Lemmon 41:89-91, pls. 14,17, 18; Partridge 41:295-296; Stewart 49:56; Tucker 21:301-302; 20:191; 26:511-512; 38:18; 38: 460,465-466,477, pl.3; 40:10,27-28; 41:572-574; Young 26:605-606; herein.)
203	Rossi (Bishop Tungsten Co., Mineral Dome)	Joseph Rossi, Bishop (1942)	25	7S	32E	MD	Scheelite in tactite. 60-ft. adit and a series of open cuts. Bishop Tungsten Co. reportedly milled 60,000 tons of ore. Mill now Bishop Concentrate and Cleaning Co. (Hess 21:269; Jenkins 42:320;Knopf 17:230, 248; Lemmon 41:102-103, pl.14; Partridge 41:292-293; Tucker 38:18; 38:462-463.
204	Round Valley (Big Shot Noble, Nobles Camp)	W.A. Trout, H.O. Johanson, Al Stevens, Howard Stevens, Bishop	34	6S	31E	MD	(Bateman 50:39-40, pls. 7,12; Hess 21:273-274; Jenkins 42:317; Lemmon 41:511-513, pls. 74,77; Partridge 41:296-297; Tucker 21:302-303; 26:512; 38:466-467,478, pl.3; herein.)

TUNGSTEN--CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Round Valley Peak	D.B. Adamson, Bishop (1942)	3	6S	30E	MD proj.	Scheelite in tactite on Round Valley Peak at altitude of 11,000 ft. Unexploited. (Jenkins 42:317; Lemmon 41:96-97,pl.14.)
205	Scheelite	----	19	8S	37E	MD	Scheelite on footwall of copper vein. Reported production 400 pounds 40% scheelite in 1907. (Jenkins 42:321; Partridge 41:297-298; Waring 19:131.)
206	Schober and Merrill	John and Arthur Schober and Fred Merrill, Bishop	22	8S	31E	MD	Scheelite, some 2-inch crystals, in garnet, epidote, hornblende gangue with considerable pyrrhotite. Deposit in fracture zone in granite. Glory hole, adit and shaft. 3000 tons of grade 1.5% WO$_3$ shipped by El Diablo Mining Co. (1943) (Jenkins 42:321; Tucker 43:60.)
	Shannon Creek						See Marble. (Jenkins 42:321.)
	Shannon Creek						See Buckshot. (Partridge 19:298.)
	Shannon Creek						See Marble. (Tucker 38:467,478,pl.3.)
207	Sheepshead and Victory (Sheep Head Claims)	Milton L. Knapp, Palm Springs, Calif. and Floyd R. Bekins Los Angeles	NE¼	19S	45E	MD proj.	(Jenkins 42:323; herein.)
208	Shorty Harris	William C. Thompson Caliente	7, 8	15S	41E	MD proj.	Also gold. Scheelite in tactite. Open cuts and a 20-ft. adit. (Jenkins 42:322; Tucker 41:574; Waring 19:129.)
	Sunnyboy	R.W. Moore (1942)	24	7S	30E	MD	Scheelite. (Jenkins 42:319.)
209	Target (Victory Tungsten Syndicate)	J.E. Babcock Estate Los Angeles, Calif. and Mr. Donahue, Big Pine	approx 14	8S	36E	MD	Herein.
210	Tip Top (Lookout)	Gilbert W. Smith, 242 E. Colorado St. Pasadena	12	7S	31E	MD	Scheelite in tactite. (Bateman 50:38,pl.7; Hess 21:272-273; Lemmon 41:508-509,pl.73.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
211	Tungstar (Crawford, Mt. Tom)	The Tungstar Corp., 705 Equitable Bldg., Hollywood 28	4, 9, 15	7S	30E	MD proj.	(Jenkins 42:318; Lemmon 41:93-94, pl.14; Lenhart 41:67-71; Partridge 41:298; Tucker 38:464,471, pl.3; herein.)
212	Tungsten Blue (Pappas)	Nick Pappas, Bishop	12	7S	31E	MD	Scheelite in tactite. Glory hole, 300-ft. haulage adit and upper adit NE of glory hole. Production through 1945 38,400 tons recovery grade 0.273% WO_3. Operated 1940 - 1941 by Bishop Tungsten Co., in 1943-44 by El Diablo Mining Co. (Bateman 50:36-37, pls. 7,11; Jenkins 42:319; Lemmon 41:510-511, pl. 73.)
	Tungsten Peak	Nick Pappas, Bishop	approx 1	7S	31E	MD	Scheelite in tactite, low grade. (Bateman 50:37, pl.7.)
	Tungsten Valley (Coyote Valley)	A.H. Peterson, John Utter estate Bishop, (1943)	7, 18, 19, 20	8S	32E	MD proj.	Scheelite in tactite. 8 separate tactite lenses. (Jenkins 42:321; Lemmon 41:103-104, pl. 14; Tucker 43:60-61.)
213	Van Loon (Raindrop)	H.A. Van Loon, Bishop	9	7S	31E	MD	Scheelite in tactite. Developed by open cut. Average grade probably less than 0.5% WO_3. (Bateman 50:38-39, pl.7.)
	Van Loon	H.A. Van Loon, Bishop	10	7S	31E	MD	Scheelite in a circular quartz body enclosed in quartz monzonite. Scheelite mined out. (Bateman 50:39, pl.7.)
	Victory	Cy Townsend, Mojave Calif. A.H. Lang, Tehachapi and Oliver Phillips, Bishop	27	8S	31E	MD proj.	Scheelite in tactite. Open cut. (Jenkins 42:321; Tucker 41:61.)
214	Waucoba (Last Rose)	Stuart Bedell, Big Pine	27	11S	37E	MD	(Eric 48:253; Jenkins 42:322; Partridge 41:312; Tucker 38:467,480, pl.3; herein.)
	West Coast Tungsten Co Mill (Keeler Gold Mines Mill)	----	approx 1, 12	17S	38E	MD proj.	Mill for tungsten ore produced in the Darwin area. Last operated in 1944. Mill dismantled (Tucker 38:403-404; 41:574-575.)

TUNGSTEN--CONT'D

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
215	**Western**	J.F. Birchim, Bert Shively, Bishop (1942)	34	6S	31E	MD	Scheelite in tactite. Open cuts, a glory hole and haulage adit. Operated 1937-38 by Pacific Tungsten Co., in 1940 by Western Tungsten Co. and in 1943 by the Tungsten Reduction Co. Mill dismantled 1944. Estimated total production 10,000 tons average grade 0.4 to 0.5% WO_3. (Bateman 50:40-42, pls. 7,13. Jenkins 42:318; Lemmon 41:513-514 pl.74.)
216	White Caps	E.C. Castle, "Cap" Aubrey. Bishop	13	7S	31E	MD	Scheelite in tactite. Adit 2500 tons of ore mined 1943 and 1944 by A.J. Smith, Bishop reported to assay 0.45% WO_3. (Bateman 50:37,38,pl.7.)
217	Yaney	Eva L. Yaney, Bishop	22	7S	32E	MD	Herein.

ASBESTOS

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
218	Huntley Industrial Minerals, Inc.	C.W. Lawrence, Bakersfield, leased to Huntley Industrial Minerals Inc. Box 305, Bishop	approx	12S or 13S	41E	MD proj.	Approx. 5 miles S of Tin Mt. Amphibole asbestos in 3 zones, each 50 to 100 ft. wide Mined by bulldozer and tractor loader and hauled to grinding plant at Laws. (Oral communication, Wright Huntley, June 1950.)
219	McIlroy	Mrs. R.B. McIlroy, Lone Pine	approx 25	16S	37E	MD proj.	Amphibole asbestos (tremolite) in limestone. Adits and open cuts.

BARITE

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
220	Gunter Canyon	Joseph Smith, Laws	NW¼	6S	34E	MD proj.	Parallel veins of barite, 2-8 ft. wide, strike N 30° W, dip 60° E in schist and slate. Considerable tonnage shipped in 1928-29. (Tucker 26:512-513; 38:481, pl.3.)
	Poso Baryta	Western Barium Corp 1643 Russ Bldg. San Francisco (1938)	23, 24	24S	36E	MD	In Tulare County. No reported production. (Tucker 38:481-482,pl.3.)
	Warm Spring Canyon	Harry P. Gower and associates 510 W. 6th St. Los Angeles	approx	22N	1E	SB	

BERYL

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Inyo	Walter J. Sorenson Gladys E. Smiley, Lone Pine. Leased to Edward L. Anderson. (1944)	--	15S	37E	MD proj.	Altered pegmatite (?) with small blue and green beryl crystals. Short adit; no production (Murdoch 48:70.)

CLAY

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
221	Calearth	Calearth Corp., W. R. Cantley, pres., Olancha. Leased to Sierra Talc and Clay Co., 5509 Randolf St., Los Angeles	13,14 23,24	18S	38E	MD proj.	Produces fuller's earth. (Tucker 38:484,pl. 3; herein.)
	Filtrol Company (Lucky Boy and Separator)		SW¼	22N	6E	SB	Several 1-6 ft. beds of bentonite overlain by 20 ft. of alluvial material. Deposit worked out (?). (Tucker 21:298; 26:514; 38:484,pl.3.)
	Green Gem	Jack Burkhardt, Lone Pine	approx 17	13S	36E	MD	Non-swelling bentonite. Prospected by Filtrol Corp. in 1948. Some turquoise found nearby.
222	Shoshone	Tidewater Assoc. Oil Co., 79 New Montgomery St., San Francisco	25	22N	6E	SB	Beds of bentonite, 7-10 ft. thick overlain by 3 to 15 ft. of alluvial material. Idle for many years. (Tucker 21:297-298; 26:514; 38:484,pl.3.)
223	Side Hill	Silicates Corporation, 230 Park Ave., New York 17, N.Y.	18, 19	26N	5E	SB	(Herein.)

FELDSPAR

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
224	Nebicite	Stuart Bedell and J.W. Newman, Big Pine	2	9S	33E	MD	(Herein.)
225	Nine Mile Canyon	E.G. Washmuth, Inyokern	13	24S	37E	MD proj	Two massive outcrops of feldspar and silica in granite on ridge west of Nine Mile Canyon. Worked by crosscut adit and glory hole. 50 tons shipped in 1930. (Sampson 31: 415–416; Tucker 38:483,pl.3.)
226	Sierra White Feldspar	Huntley Industrial Minerals, Inc., Box 305, Bishop	11 ?	9S	33E	MD proj	(Herein.)
227	White King	H.W. Wright So. Pasadena (1938)	31, 32	23S	37E	MD	Massive outcrops of feldspar. Several cars shipped in 1933. (Tucker 38:483,pl.3.)

FLUORITE

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
228	Warm Spring	General Chemical Div. Allied Chemical and Dye Corp. 40 Rector St. New York, N.Y.	—	22N	1E	SB proj.	Fluorite in pegmatite (?). Grade 29 to 65% CaF_2. Worked by three adits. (Tucker 38: 483–484, pl.3.)
	Wine Fluorspar	Wade H. Wine, 2165 Plumas St. Reno	13 ?	19S	44E	MD proj.	Fluorite in dolomite (?). Worked by shallow inclined shaft.

GARNET

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Various tungsten properties in the Bishop area.	----	--	--	--	--	Garnet produced as a by-product from tungsten milling operations. See Garnet herein.

GRAPHITE

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Panamint	Jack Stuart, Darwin, (1940)	--	17S	44 or 45E	MD proj.	In Telephone Canyon, 3 miles E of Emigrant Springs Canyon highway. Graphitic shale along shear zone strikes N 60° W. Unworked prospect.

ICELAND SPAR

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
229	Iceland	W.R. Wallace, Darwin	--	19S	40E	MD	Three miles from Darwin. Recrystallized calcite along shear zone in dark colored limestone. No production.

LIMESTONE, DOLOMITE, MARBLE, ONYX MARBLE TRAVERTINE

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	LOCATION T.	LOCATION R.	LOCATION B & M	REMARKS
230	Amargosa Marble Co.	Leased to Jack Rogers and Emory Arnold, Death Valley Junction (1948)	--	26N	3E	SB proj.	Produces travertine. (Herein.)
	Badgley						See Inyo Marble Co. (Logan 47:243.)
	Betty Ann						See J.D.G. Marble.
	Blue Star Mines Ltd.	Blue Star Mines Ltd John Spindler, pres., 667 So. Anderson St. Los Angeles	36	9S	32E	MD	Limestone. See description in section on talc. (Logan 47:243.)
231	Death Valley	H.C. Degner, Beverly Onyx Marble Co., 623 N. La Peer St., West Hollywood	6?	22S	43E	MD proj.	Onyx marble. (Tucker 38:482,pl.3.herein.)
	Emily May						See J.D.G. Marble.
232	Inyo Marble Company	Inyo Marble Co. D.H. Dunn, pres., 728 E. 29th St. Los Angeles	4,10 11,13, 14,24 25 and 19,30, 31	16S 16S	37E 38E	MD proj. MD proj.	Dolomite, marble; (Aubury 06:99-100; Crawford 94:392; 96:628; DeGroot 90:215-218; Hamilton 22:52; Hill 12:86-87; Logan 47:244-245; Tucker 21:295; 26:515-516; 38:482; Waring 19:111; herein.)
233	J.D.G. (Emily May, Betty Ann)	John Powers, et al	27	17S	40E	MD	Marble. (Herein.)
	Rogers		approx	6S	34E	MD proj.	Limestone. (Logan 47:245.)
234	West End Chemical	West End Chemical Co., 608 Latham Square Bldg., Oakland	9,10, 15	23S	43E	MD proj.	Limestone. (Logan 47:245; Tucker 26:515; herein.)

MICA

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
235	Death Valley Mica (Pegma)	Louise Blossom 2351 N. Garfield Altadena. Leased to J.E. Carol and G.O. Mosbarger, Shoshone	23,24	21N	4E	SB proj.	Scrap mica herein.

PERLITE, PUMICE, PUMICITE, AND
VOLCANIC CINDERS

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	American Pumice						See Desert Materials
236	Brooke	Douglas Robinson and Mrs. Lunsford Yardell, Bishop, and associates. Leased to Arthur Detloff, Big Pine	24, 25	10S	33E	MD	Perlite (Herein.)
237	California-Nevada Building Materials Producers	R.H. Thompson, Mayfair Hotel, Inyokern. Leased to California-Nevada Building Materials Producers, 3723 Wilshire Blvd., Los Angeles	19	21S	38E	MD	Pumice. (Herein.)
	Coso Mountain	Within U.S. Naval Ordnance Test Station, Inyokern	--	--	--	--	Pumice. Six miles E of Coso Junction. (Tucker 26:521; 38:521,pl.3.)
	Coso	Within U.S. Naval Ordnance Test Station, Inyokern	--	21, 22S	38E	MD	(Herein.)
238	Desert Materials	Desert Materials Corp., 6321 Wilshire Blvd., L.A.	13,14 21,22 23,24 35	21S	38E	MD	Pumice. (Herein.)
			11	22S	37E	MD proj	
239	Fish Springs	Morris Albertoli, 2702 Glendale Blvd. Los Angeles, and M. Frey, Los Angeles Leased to H. Denbigh Ellis, 650 S. Spring St, Los Angeles (1948)	19,30	10S	34E	MD	Perlite. (Herein.)

PERLITE, PUMICE, PUMICITE, AND VOLCANIC CINDERS

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
239	Fish Springs	Morris Albertoli, 2702 Glendale Blvd. Los Angeles and M. Frey, Los Angeles. Leased to H. Denbigh Ellis, 650 S. Spring St., Los Angeles (1948)	19,30	10S	34E	MD	Perlite. (Herein.)
	Glendenning						See Virginia.
	Gunter Canyon						See Hidecker.
240	Hidecker (Gunter Canyon)	William Rea and Tom Gracy, Bishop (1938)	12,13 (?)	6S	33E	MD proj.	Pumice. (Tucker 26:251; 38:485,pl.3.)
241	Inyo Pumice Corporation	William J. Petty, Inyokern. Leased to Inyo Pumice Corp. 11314 So.Luitwieler Rd., Whittier	19	21S	38E	MD proj.	Pumice. (Herein.)
242	Jamieson	Alexander Jamieson Big Pine. Leased to H.W. Frey and R.W. Bidwell, Los Angeles	8	8S	34E	MD proj.	Pumice. (Herein.)
	Little Lake						See Desert Materials. (Tucker 38:485.)
243	Oasis (Cornucopia)	Frances E. Patton and F.S. Longley, locators. (1946)	--	6S	37E	MD	Pumice. 3½ miles S of Mono County boundary line on the E side of the Westgaard Pass road. (Herein.)
	Pacific Coast Pumice Company (Mill)	Pacific Coast Pumice Co., C.W. Churchill, Box 446, Bishop	28	6S	33E	MD	Grinding plant. Deposit in Mono County.
	Pumice Products Company						See Desert Materials Company (Tucker 38:485-486.)

PERLITE, PUMICE, PUMICITE, AND VOLCANIC CINDERS

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
244	Redlite Aggregate, Inc	C.D. Ray, et al.	N½ 31	22S	38E	MD	Volcanic cinders (Herein.)
245	Round Mountain	Henry Babineau, 6204 Woodward Ave., Bell	19	21S	38E	MD	Pumice (Herein)
246	Sheephead Mountain	Harry Gower and Donald Seal, Death Valley Junction	--	21N	5E	SB proj.	Perlite. Eight miles southwest from Shoshone on east flank of Sheephead Mountain. (Herein)
247	Shoshone	Ed Grimshaw, Tecopa Calif., A.W. Stalker and Walter Davis, Shoshone	approx 26,35	22N	6E	SB	Perlite. (Herein)
248	Shoshone	Charles Brown, Shoshone,	--	22N	7E	SB proj.	Pumicite. One-fourth mile south of Shoshone. (Tucker 26:521; 38:486,pl.3; herein.)
	Sierra Minerals, Inc.	L.T. Lynn, Homer Chase, John D. Calloway, Olancha (1938)	--	20S	37E	MD	Pumice. Four miles SE of Olancha. (Tucker 38:486,pl.3.)
	Southern Death Valley	Harry Gower, Tom Wilson, and Donald Seal, Death Valley Junction	--	--	--	--	Perlite. Four miles SW of Bennetts Well, Death Valley. (Herein.)
249	Staats	D.E. Staats, Keeler	--	18S	38E	MD proj.	Perlite. Thirteen miles S of Keeler. (Herein)
	Tripoli	Patrick Miler, William Maher, Death Valley Junction (1938)	--	--	--	--	Pumicite. Six miles S of Death Valley Junction and 1 mile SW of Eagle Mountain. (Tucker 38:486.)
	Virginia (Glendenning)	R.W. Glendenning Los Angeles (1938)	31,32	22N	7E	SB	Pumicite. (Tucker 26:521-522; 38:486,pl.3.)
250	Van Loon "fines"	H.A. Van Loon, Bishop	8,18	6S	33E	MD	Pumice. (Herein.)

PERLITE, PUMICE, PUMICITE, AND

VOLCANIC CINDERS

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
251	Volcanic Cinder Co.	C.D. Ray, Glendale, Lafayette Morrison, Huntington Beach; George Rouff and Henry B. Jarvis, Little Lake. Leased to Henry B. Jarvis and assoc., Little Lake.	S$\frac{1}{2}$ 30	22S	38E	MD	Volcanic Cinders (Herein)
252	W-W (Indian Wells Pumice Products, Inyo Pumice Producers, Lucky Lager, Petty's Pit)	Wm. J. Petty, P.O. Box 20, Inyokern Leased to W-W Pumice Co. 4040 Wilshire Blvd., Los Angeles.	18,19	21S	38E	MD	Pumice. (Herein.)

SAND, GRAVEL, AND CRUSHED STONE

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Bishop Engineering and Construction Co.	Bishop Engineering and Construction Co., Box 505, Bishop	approx	6S	33E	MD	Crushing and screening plant for concrete aggregate. Capacity 400 yards per day, all sizes. Operating on land leased from City of Los Angeles, Department of Water and Power.
	Mt. Whitney Rock Products Company	G.L. Watterson, Lone Pine					Near Lone Pine

SLATE

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
253	Slate Deposit	Mrs. R.B. McIlroy, Lone Pine	approx.	16S	38E	MD proj.	Beds of black, gray, and red slate strike N 30° W, dip 70° W. Material shipped in past years for roofing granules and flagstone. (Tucker 38:487.)

SULPHUR

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
254	Crater	Mrs. Mary M. Bonthrone, 594 San Luis Road, Berkeley 7, and W.J. Wallace Estate, Pomona	33,34	8S	39E	MD	(Lynton 38:563-590; Tucker 21:300; 26:523; 38:489-491,pl.3; Waring 19:126; herein.)
255	Gulch	Stephania M. Beal, and associates, 163 N. Swall Dr. Beverly Hills and C.J. Seely, 1035 3rd Ave. Los	33,34	8S	39E	MD	Worked by tunnels and open pit. Last operated in 1940. During 6 months of 1939, 1000 tons of ore, 85 percent sulphur, shipped to Los Angeles Chemical Company. (Lynton 38: 566, fig.2; Tucker 21:300; 26:523; 38:492,pl 3; Waring 19:126.)
256	Southwest Sulphur	Southwest Sulphur Company, E.R. Gaughn, sect-treas. 8321 Fir Ave., Los Angeles	28,33 34	8S	39E	MD	Worked by shafts. (Lynton 38:566,588,fig. 2; Tucker 21:300; 26:523; 38:491.)
	Sulphur Queen	Graoe L. Steward, Big Pine	--	8S	39E	MD	
257	Yellow Sulphur	Hicks Brothers, Big Pine	--	8S	39E	MD	(Lynton 38:fig.2,3.)

TALC

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
258	Alberta	William Bonham, Lone Pine	--	16S	38E	MD proj.	(Herein)
259	Alliance	Edith Lockhart and George Koest, Box 75, Darwin	20,29 30	18S	40E	MD	(Page 48:12; herein.)
260	Blue Star Mines Ltd.	Blue Star Mines, Ltd., John Spindler, pres., 667 So. Anderson St., Los Angeles	approx 36	9S	32E	MD proj.	Also limestone. (Tucker 38:492,pl.3; Logan 47:243; herein.)
261	Blue Stone	Walter Sorenson, Lone Pine	approx	12S	36E	MD	Talc (Herein)
262	Bob Cat (East End)	R.H. Bagley (1942)	28	18S	40E	MD proj.	(Herein)
	Bradley (Doris D)	Sierra Talc and Clay Co., 5509 Randolph St., Los Angeles	--	13S	37E	MD proj.	Talc in limestone and dolomite. Worked by adit, winze and open cut.
	Comet No. 1 and No. 2						See Eclipse. (Newman 23:539; Tucker 38:471, pl.3.)
	Davis (High Chief)	Mrs. J.E. Davis Big Pine	approx 12	9S	34E	MD	Talc in limestone. Worked by adits. (Tucker 38:492-493, pl.3.)
263	Death Valley Talc Company	Death Valley Talc Co., S.E. Chiapella vice-president, 1625 N. Las Palmas Ave., Hollywood	approx	22S	47E	MD proj.	(Tucker 38:493, pl.3; herein.)
264	Donna Loy (Paulson)	L.D. Fairbanks Daggett	approx 26	20N	8E	SB proj.	(Herein)
	East End						See Bob Cat

TALC

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
265	Eclipse (California Mineral Corp., California Talc Co., Comet No. 1 and No. 2, Eclipse No. 1 and No. 2	A.E. Nicholls 1400 E. Olympic Blvd., Los Angeles. Leased to Kennedy Minerals Co., 2550 E. Olympic Blvd., Los Angeles	13, 7, 18	20N 20N	5E 6E	SB proj SB proj.	(Newman 23:539; Tucker 21:300 26:523; 38: 472, pl.3; Waring 19:126; herein.)
266	Eleanor	G.P. Rogers and Frank Henderson, Lone Pine	--	13S	37E	MD proj.	(Herein.)
	Florence					proj.	See White Mountain (Tucker 38:493, pl.3.)
267	Frisco	State of California leased to Sierra Talc and Clay Co., 5509 Randolph St., Los Angeles	36	18S	39E	MD proj.	(Herein)
	Goldbelt		--	15S	41E	MD proj.	
	Hilderman		--	14S	38E	MD proj.	Operated by James Nikolaus, Big Pine
	Inyo Talc Company						See Talc City. (Newman 23:421; Tucker 20: 191; 26:523.)
268	Irish (Quackenbush)	Mrs. Eva Irish Los Angeles (1942)	SW¼	18S	40E	MD	(Herein.)
269	Lakeview	A.C. and Raymond Palmer, Lone Pine	--	16S	38E	MD proj.	2½ miles north-northwest of Keeler. (Herein)
270	Lakeview	H. Taylor and H. Stewart, Big Pine	4 ?	16S	37E	MD proj.	(Herein.)
271	Longhorn	W.H. Anderson, 517 N. Ave. 50, Los Angeles 42 and G. Cluggage.	approx	8S	37E	MD	In Eureka Valley. Steatite talc body, 3½ to 7 ft. wide.

TALC

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
272	Markley	Sierra Talc and Clay Co., 5509 Randolph St., Los Angeles	35 2,11	21N 20N	5E 5E	SB proj. SB proj.	(Herein.)
273	Montgomery	H.P. Gower and associates, 510 W. 6th St., Los Angeles Calif. Leased to Sierra Talc and Clay Co., 5509 Randolph St., Los Angeles.	—	22S	46E	MD proj.	(Herein)
274	Nikolaus	James Nikolaus Big Pine.	approx 23	8S	37E	MD	(Herein)
	Owlshead Mountain	----	--	--	--	--	(Herein)
	Pacific Coast Talc Company (Mt. Whitney Talc Co.)						See Trinity and Frisco. (Tucker 38:493-494, pl.3.)
	Quackenbush						See Irish Lease.
	Sierra Talc Company						See Frisco Markley, Montgomery, Talc City, Trinity, White Eagle and White Mountain. (Tucker 38:494,pl.3.)
275	Silver Dollar	Edith Lockhart, George Koest, Darwin	28,29	18S	40E	MD	(Herein)
	Simonds						See Talc City (Tucker 21:300-301; 26:523; Waring 19:126-127.)
276	Southern California Mineral Company	Southern Calif. Minerals Co., 320 So. Mission Rd., Los Angeles	approx	21N	1E	SB proj.	Five claims between Warm Spring and Anvil Canyons.

TALC

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
277	Talc City (Inyo Talc Co., Sierra Talc Co., Simonds)	Sierra Talc and Clay Co., 5509 Randolph St., Los Angeles	28,29 32,33	18S	40E	MD	(Page 48:12; Tucker 38:494,pl.3; Wright 50:127-128; herein.)
278	Trinity (Pacific Coast)	Sierra Talc and Clay Co., 5509 Raldolph St., Los Angeles, and State of California	25,36	18S	39E	MD proj.	(Herein)
279	Ubehebe	Sierra Talc and Clay Co., 5509 Randolph St., Los Angeles	--	15S	41E	MD proj.	Steatite grade talc in limestone and dolomite. Worked by adits, intermittently before 1945.
280	Victory	Edith Lockhart and George Koest, Box 75, Darwin	approx	18S	39E	MD proj.	(Herein)
281	Viking	Edith Lockhart and George Koest, Box 75, Darwin	23,24	18S	39E	MD proj.	(Page 48:12; Wright 50:128; herein.)
282	Warm Spring	Miss Louise Grantham and associates 809 E. 6th St.	4,5 ?	21N	1E	SB proj.	(Tucker 38:494, pl.3; herein.)
283	White Eagle	Sierra Talc and Clay Co., 5509 Randolph St., Los Angeles. Leased by Wright Huntley, Bishop	NE¼	13S	37E	MD proj.	(Herein.)
	White Horse	----	--	15S	41E	MD	Adjoins Ubhebe on south.
284	White Mountain (Florence)	Sierra Talc and C Clay Co., 5509 Randolph St. Los Angeles	--	16S	38E	MD proj.	

TALC

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
285	White Mountain (Cerro Gordo Soapstone, Troeger.)	Roy C. Troeger, 4600 Encino Ave., Encino	—	16S	38E	MD proj.	(Page 48:12-13; Tucker 26:524; 38:495, pl. 3; Wright 50:128; herein.)
286	White Swan	Edna M. Towers, 316 W. Imperial Highway	23	18S	39E	MD	(Page 48:12; Wright 50:128; herein.)
287	Willow Creek	Emil Carlson(1942)	NE¼	13S	37E	MD proj.	(Herein)

TURQUOISE

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Green Gem						See under Bentonite.

WOLLASTONITE

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Contact	Louise B. Grantham, 809 E. 6th St., Ontario	--	23S	47E	MD proj.	Wollastonite in limestone, unexploited

GRINDING PLANTS

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Blue Star Mines, Ltd.	Blue Star Mines, Ltd., 667 So. Anderson St., Los Angeles					Plant at Zurich.
	Huntley Industrial Minerals, Incorporated	Huntley Industrial Minerals, Inc. Box 305, Bishop					Plant at Laws.
	Pacific Coast Pumice Company						Plant at Laws.
	Sierra Talc and Clay Company	Sierra Talc and Clay Co., 5509 Randolph St., Los Angeles					Plant at Keeler. See Talc City.

BORAX

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
290	Gerstley (State Lease)	United States Borax Co., 510 W. 6th St. Los Angeles and State of California (State Lease No.15)	8,9 17 16 (NW¼)	22N	7E	SB	Colemanite and ulexite occur as bedded deposits in Tertiary lake beds, which are capped by basalt. Workings consist of adits, drifts, cross-cuts, and stopes. Worked intermittently, ore being hauled by truck to Dunn for rail shipment. (Noble 26; Tucker 26:525-526.)
293	Lila C	Borax Consolidated Ltd., 510 W. 6th St Los Angeles	1, 12	24N	4E	SB	Worked by Pacific Coast Borax Co., 1907-15. (Tucker 38:pl.3; Waring 19:63.)
	Pacific Coast Borax Company	Pacific Coast Borax Division, Borax Consolidated, Ltd., 510 W. 6th St. Los Angeles	--	--	--	--	Numerous claims held in Death Valley and adjacent area to east. Principal production from deposits near Ryan, Biddy McCarty, Grand View, Lizzie V. Oakley, Widow and Played Out mines. (Tucker 274-277; 26:524-525; 38:496, pl.3; Waring 19:62-69.)
	Pittsburgh Plate Glass Company	Columbia Chemical Division Glass Co. Pittsburgh 13, Pennsylvania	19,30 31,32	17S	37E	MD	See under soda. Also produces soda ash and trona.

GYPSUM

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Acme Cement and Plaster Co.						See Gypsum Rock.
298	Gypsum Rock (Acme Cement and Plaster Co.)	Certain-teed Products Corp., 120 E. Lancaster Ave., Ardmore, Pennsylvania	26	20N	7E	SB	Idle. Twenty feet of Gypsum beds, 6 inches to 3 feet thick, are in brown clay shale. Worked 1914-18. (Tucker 21:282; 26:526; Waring 19:85-87; VerPlanck 50.)
299	Pacific Coast Borax Division, Borax, Consolidated Limited	Borax Consolidated Limited, 510 W. 6th St., Los Angeles	6?	25N	4E	SB	Unworked gypsum beds in foothills of Black Mountains near Ryan. (Tucker 21:282; 26:526; Waring 19:87.)

NITRATES

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
300	Upper Canyon (Nitre Bed)	Pacific Nitrate Company, c/o W.H. Woodbine, 5633 Sunset Blvd., Hollywood 28	27,28 33,34	20N	7E	SB	(Bailey 02:165-174; Noble 22; 31:62-71, 88-91; Tucker 21:296; 26:526; 38:496-497, pl. 3; Waring 19:117-119.)

POTASH

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
301	Deep Springs Valley	A.G. Barmore, and associates, Big Pine, (1938)	4,9	8S	36E	MD	Formerly owned by Inyo Chemical Co. No production. (Gale 14:420; Tucker 21:296, 26:526 38:497, pl.3; Waring 19:120.)

SALT

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
302	Saline Valley	----	23, 26	14S	38E	MD proj.	Idle, last worked in 1930. (Bailey 02:118; Gale 14:416-421; 19:179-181; Tucker 21:297; 26: 527; 38:498-499, pl.3; Waring 19:122-123)

SODA

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
303	Natural Soda Products Company Plant	Natural Soda Products Company, a division of the Wyandotte Chemical Corporation, 506 Central Tower Bldg. San Francisco	9 and others	17S 16S 16S	38E 37E 38E	MD MD MD proj.	Also produces trona.(Chalfant 33:300; Dub 47:73-76; Hamilton 20:38; 22:62; Newman 23: 421; 23:32; Tucker 21:278,299; 24:190-191; 26:530; 38:500, pl.3; 40:15; Waring 19:74, 121, 125-126; herein.)
304	Permanente Metals Corporation Plant	Permanente Metals Corporation, D.A. Rhodes, vice pres., Kaiser Bldg., Oakland	18	18S	37E	MD	Also produces trona. (Dub 47:77, herein.)
305	Pittsburgh Plate Glass Soda Plant (Pacifio Alkali Co., Kuhnert Syndicate)	Columbia Chemical Division, Pittsburgh Plate Glass Co., Pittsburgh 13, Pennsylvania	19,30 31,32	17S	37E	MD	Also produces trona and borax. (Dub 47:75-77; Tucker 26:529-530; 38:499; 40:15; herein.)

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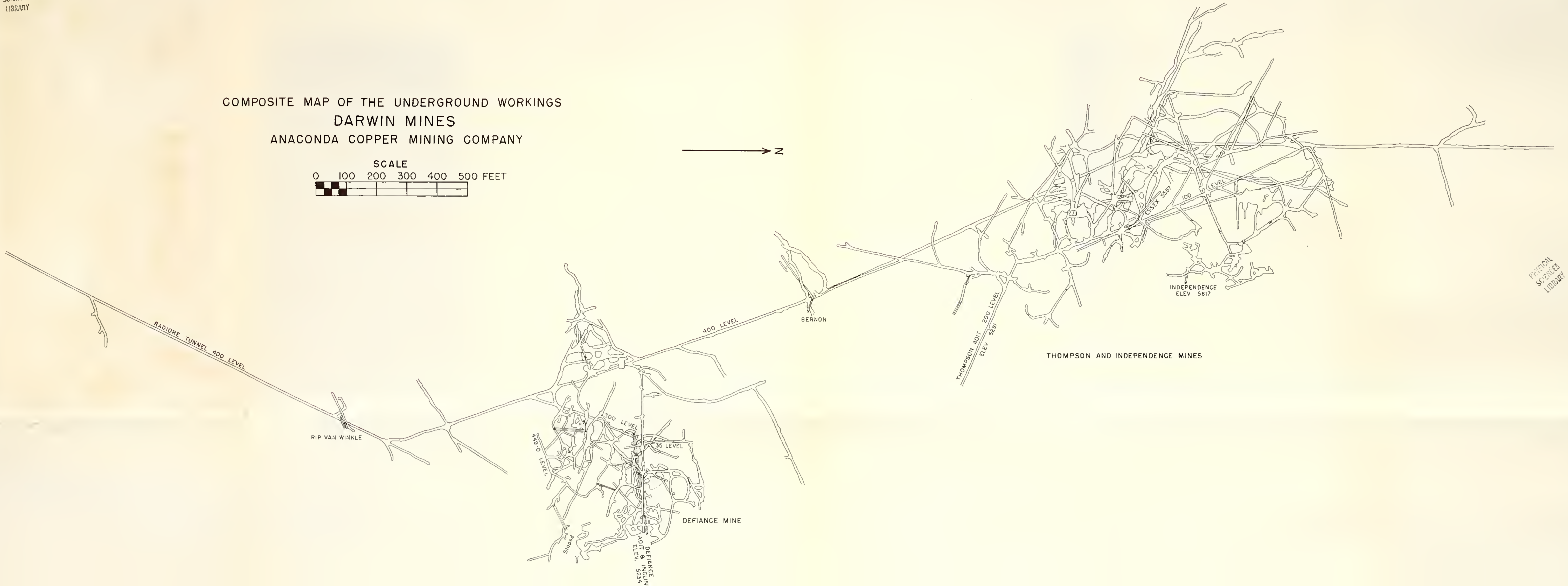
COMPOSITE MAP OF THE UNDERGROUND WORKINGS
DARWIN MINES
ANACONDA COPPER MINING COMPANY


SCALE
0 100 200 300 400 500 FEET
N
RADIORE TUNNEL 400 LEVEL
RIP VAN WINKLE
400 LEVEL
BERNON
300 LEVEL
449·0 LEVEL
35 LEVEL
Stoped
DEFIANCE MINE
DEFIANCE ADIT & INCLIN ELEV. 5234
THOMPSON ADIT 200 LEVEL ELEV 5291
ESSEX 5557
100 LEVEL
INDEPENDENCE
ELEV 5617
THOMPSON AND INDEPENDENCE MINES

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CALIFORNIA JOURNAL
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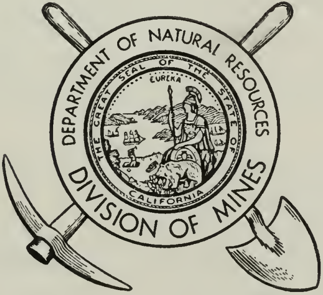

STATE OF CALIFORNIA
EARL WARREN, Governor
DEPARTMENT OF NATURAL RESOURCES
WARREN T. HANNUM, Director

DIVISION OF MINES
OLAF P. JENKINS, Chief

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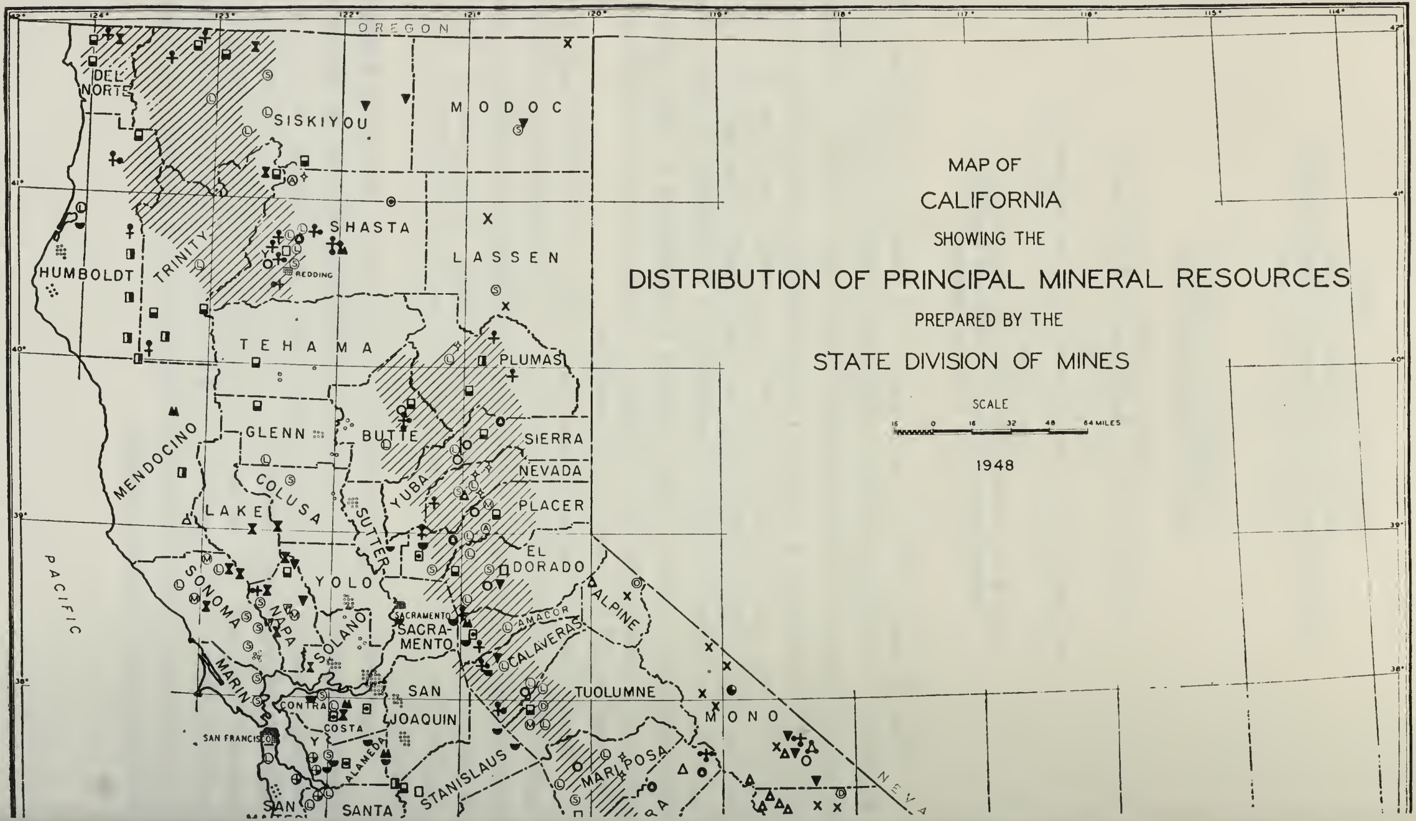
The Division of Mines maintains at its headquarters offices in San Francisco a technical library containing several thousand books and scientific journals on geology, mining, mineralogy, chemistry, metallurgy, and related subjects; a reading room containing periodicals devoted to the petroleum and mining industries, and newspapers from the mining centers of the state; exhibits of minerals, rocks, mine models, etc.; a service laboratory for the determination of California minerals; and a conference room with a mining engineer in attendance to serve the public and to sell publications of the Division. Publications are also sold at the Los Angeles and Sacramento district offices.

In addition to oral conferences in the offices of the Division of Mines, information concerning the mineral resources, mineral industry, geology, and mining operations of California is distributed to the public by means of publications, monthly releases, and letters. Each letter of inquiry received by the Division is answered by the technical staff member best qualified to do so.

The principal publications of the Division of Mines are **Bulletins, Special Reports,** and the quarterly **California Journal of Mines and Geology,** issued in January, April, July, and October of each year. **Mineral Information Service** is a monthly news release concerning the mineral resources and industry of California, designed to inform the public of discoveries, operations, markets, statistics, and new publications. It is distributed without cost upon request. A list of available publications will also be sent free upon request.



MAP OF
CALIFORNIA
SHOWING THE
DISTRIBUTION OF PRINCIPAL MINERAL RESOURCES
PREPARED BY THE
STATE DIVISION OF MINES

SCALE

1948

16 0 16 32 48 64 MILES
OREGON
NEVA
PACIFIC
DEL NORTE
SISKIYOU
MODOC
HUMBOLDT
TRINITY
SHASTA
LASSEN
REDDING
TEHAMA
PLUMAS
GLENN
BUTTE
SIERRA
NEVADA
MENDOCINO
YUBA
PLACER
COLUSA
LAKE
SUTTER
EL DORADO
YOLO
ALPINE
SONOMA
NAPA
SOLANO
SACRAMENTO
SACRA-MENTO
AMADOR
CALAVERAS
MARIN
SAN JOAQUIN
TUOLUMNE
MONO
CONTRA COSTA
SAN FRANCISCO
ALAMEDA
STANISLAUS
MARIPOSA
SAN MATEO
SANTA
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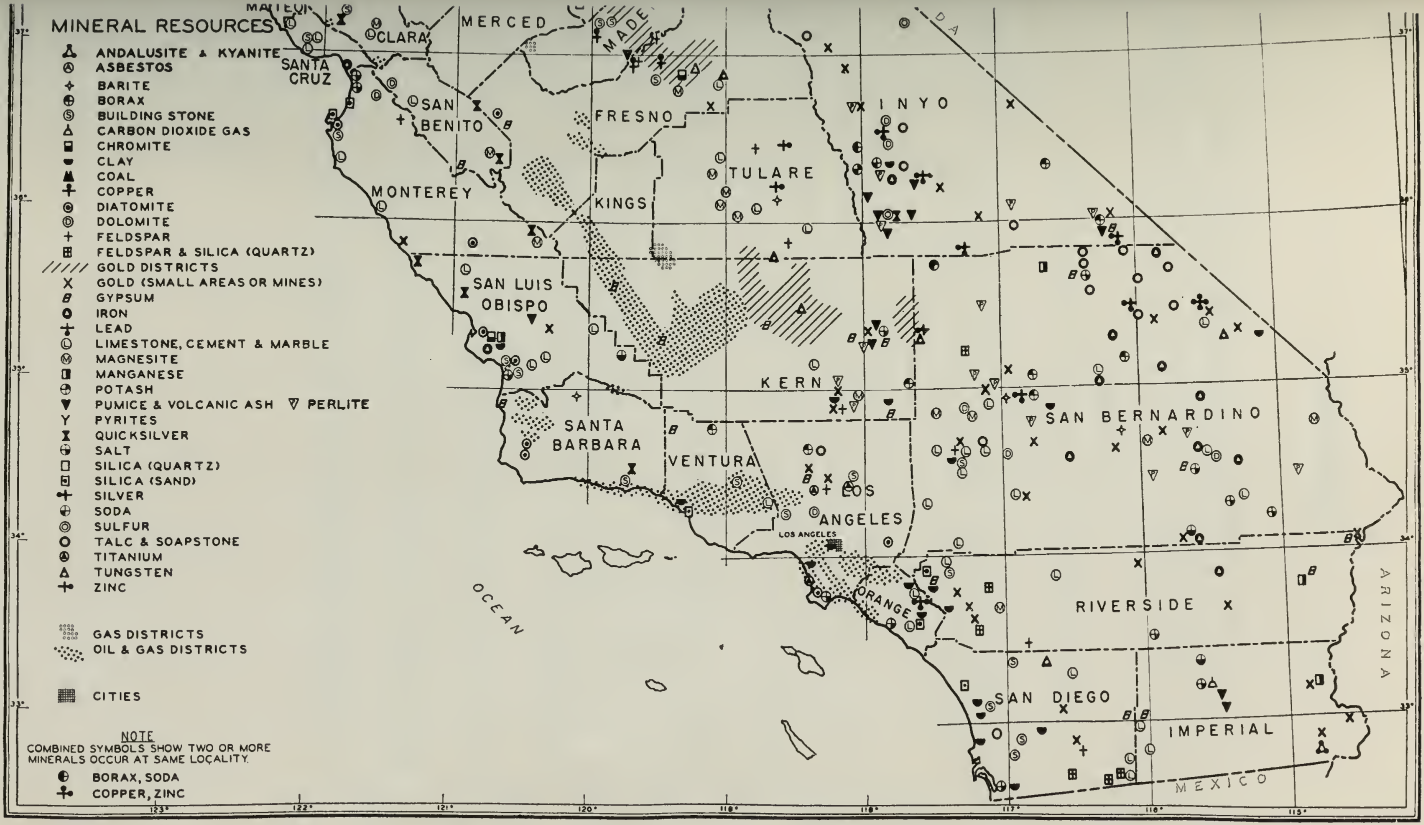
114°


MINERAL RESOURCES
ANDALUSITE & KYANITE
ASBESTOS
BARITE
BORAX
BUILDING STONE
CARBON DIOXIDE GAS
CHROMITE
CLAY
COAL
COPPER
DIATOMITE
DOLOMITE
FELDSPAR
FELDSPAR & SILICA (QUARTZ)
GOLD DISTRICTS
GOLD (SMALL AREAS OR MINES)
GYPSUM
IRON
LEAD
LIMESTONE, CEMENT & MARBLE
MAGNESITE
MANGANESE
POTASH
PUMICE & VOLCANIC ASH
PERLITE
PYRITES
QUICKSILVER
SALT
SILICA (QUARTZ)
SILICA (SAND)
SILVER
SODA
SULFUR
TALC & SOAPSTONE
TITANIUM
TUNGSTEN
ZINC
GAS DISTRICTS
OIL & GAS DISTRICTS
CITIES
NOTE
COMBINED SYMBOLS SHOW TWO OR MORE MINERALS OCCUR AT SAME LOCALITY.
BORAX, SODA
COPPER, ZINC
MATEO
SANTA CRUZ
CLARA
MERCED
MADERA
SAN BENITO
FRESNO
MONTEREY
KINGS
TULARE
INYO
SAN LUIS OBISPO
KERN
SANTA BARBARA
VENTURA
LOS ANGELES
SAN BERNARDINO
ORANGE
RIVERSIDE
SAN DIEGO
IMPERIAL
ARIZONA
MEXICO
DA
OCEAN
37°
36°
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118°
117°
116°
115°

CONTENTS

Page

Annual Report, Division of Mines, For the One Hundred First Fiscal Year, July 1, 1949 to June 30, 1950, by Olaf P. Jenkins 233

Counties of California, Mineral Production and Significant Mining Activities of 1949, by Charles V. Averill and L. A. Norman Jr. 271

SUPPLEMENT

Publications of the California State Division of Mines

PLATES

Plate 19. *A*, Quarry and crushing plant, American Perlite Company Fish Springs, Inyo County. *B*, Quarry, Redlite Cinder Company, Inyo County 336-337

20. Johns-Manville Celite plant, Lompoc, Santa Barbara County 336-337

21. Plant and quarry, Rocklite Products, Ventura 336-337

22. Monolith Portland Cement Company plant, Monolith, Kern County 336-337

23. Johns-Manville Celite plant, Lompoc, Santa Barbara County 336-337

24. *A*, Bucket-line dredge, Yuba Consolidated Gold Fields, Butte County. Hydraulic mining at the Rex mine near Weaverville, Trinity County 336-337

25. *A*, Basalite plant, Basalt Rock Company, Stockton, San Joaquin County. *B*, Loading a kiln, Sacramento Brick Company, Sacramento County 336-337

26. *A*, Mill, Sarita Milling Company, Chemung mine, Mono County. *B*, Sarita mine, near Masonic, Mono County 336-337

27. *A*, Gypsum quarry, Monolith Portland Cement Company, Quatal Canyon, Ventura County. *B*, Processing plant, Insulating Aggregate Company, Mono County 336-337

28. *A*, Kaolin deposit, Huntley Industrial Minerals, Inc., Mono County. *B*, Fouch pit, Glass Mountain, Siskiyou County 336-337

29. *A*, Quarry and screening plant, Structurelite Company, Modoc County. *B*, Loading black pumice at quarry, U.S. Pumice Supply Company, Mono County 336-337

30. *A*, Eagle Mountain iron deposit, Kaiser Company, Inc., Riverside County. *B*, Eagle Mountain iron deposit, Kaiser Company, Inc., Riverside County 336-337

ANNUAL REPORT OF THE STATE MINERALOGIST CHIEF OF THE DIVISION OF MINES

FOR THE

101ST FISCAL YEAR, JULY 1, 1949, TO JUNE 30, 1950 ANNUAL REPORT REQUIRED BY AMENDED SECTION 2203, PUBLIC RESOURCES CODE

By Olaf P. Jenkins *

OUTLINE OF REPORT

	Page
Letter of transmittal	233
Introduction	234
Outline of the organization of the Division of Mines	235
Personnel	235
Financial statement	236
Information service	237
Public appearances	238
Mineral laboratory	239
Mineral exhibits	240
Mineral accessions to the museum	240
Library	242
Publications by the Division of Mines	251
Ore buyers' licenses and inspection	254
Mineral statistics	255
Survey of mining activities	259
Survey of mineral utilization	260
Survey of mineral commodities	260
Contributions to exploration for mineral fuels	261
Basic geologic mapping	264
Regional state map	266
Mining and geologic guidebooks	267
Continued growth of the Los Angeles branch	267
Report of U. S. Geological Survey on cooperative program	268
Conclusions	270

Illustrations

Figure 1. Graph showing growth of public interest in publications of the Division of Mines, 1937-1950	250
2. Circle graph showing comparative value of production of mineral fuels, non-metallics, salines, and metals for the year 1949. Line-graph showing growth in mineral wealth of California from 1905 to 1950	256
3. Map of California; Index to quadrangles	262-263

LETTER OF TRANSMITTAL

General Warren T. Hannum
Director, Department of Natural Resources
Sacramento, California

Sir: I have the honor to transmit herewith for reference to Governor Earl Warren the annual report of the State Mineralogist, Chief of the Division of Mines, for the 101st fiscal year, July 1, 1949 to June 30, 1950.

This is in accordance with the requirement provided in the amended Section 2203 of the Public Resources Code.

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* State Mineralogist and Chief of the Division of Mines, Department of Natural Resources, State of California.

The same general plan has been followed in this report as in the annual report for the previous fiscal year. The different activities of the Division of Mines are described briefly in the order of its functions. Sections of the Public Resources Code are quoted throughout the report in order to give documentary evidence of what is required of the Division of Mines.

A state with a growing population and rapidly increasing industry calls for greater and more diversified service from its departments. California, with its important and diversified mineral resources, both developed and potential, must provide adequate information to the public to gain the best possible results; it is the function of the Division of Mines, by law, to make available this information, and so to increase the wealth and prosperity of California.

The Division of Mines shows a distinct growth in service to the public in its general trend of activities. It may, therefore, well be proud of the part it has played in assisting the state to reach the billion-dollar mineral production that is now on record.

Respectfully submitted,

Olaf P. Jenkins
State Mineralogist and
Chief of the Division of Mines

Ferry Building, San Francisco
September 1, 1950.

INTRODUCTION

Public Resources Code:

> **"2203. The State Mineralogist shall make an annual report to the Director for transmission to the Governor on or before the fifteenth day of September next preceding the regular session of the Legislature."**

The activities of the Division of Mines for the 101st fiscal year, July 1, 1949 to June 30, 1950, are arranged and summarized in this annual report by functions and accomplishments. Statements are also made as regards work which is planned for the future, based on present needs in the industry.

As this report is being prepared, however, the Division is cognizant of the fact that a national emergency is imminent and it may become necessary to adjust the Division's plans to meet this emergency by bending every effort toward the development of those minerals needed during time of war.

This annual report is submitted to the Director of Natural Resources in typewritten form for transmission to the Governor of California. It is intended that the report will finally be published in the forthcoming April 1951 issue of the quarterly publication of the Division, *California Journal of Mines and Geology*.

OUTLINE OF THE ORGANIZATION OF THE DIVISION OF MINES

- Administration Branch
  - Personnel control
  - Office management control
    - Fiscal control section
    - Maintenance and service section
      - Stock and mailing
      - Mailing lists
      - Janitor service
  - Publications control
    - Editorial section
    - Drafting and illustrations section
- Geologic Branch
  - Mineralogical control
    - Public service laboratory section
    - Research laboratory section
    - Exhibits section
  - Mineral commodity survey
    - Metallics section
    - Non-metallics section
    - Mineral fuels section
  - Geologic survey
    - Geologic mapping section
    - Guidebook section
- Mining Engineering Branch
  - Public information control
    - Library section
    - Information section
    - Mineral statistics section
    - Ore buyer's licensing
  - Mining activities survey
    - County activities in northern California
  - Mineral utilization survey
    - Mineral markets in northern California
- Division of Mines Branch (Los Angeles)
  - Public information control
    - Information, library and exhibits
  - Mining activities survey
    - County activities in southern California
  - Mineral utilization survey
    - Mineral markets in southern California

PERSONNEL

Public Resources Code:

> "2201. The State Mineralogist shall employ competent geologists, field assistants, qualified specialists, and office employees when necessary in the execution of the plans and operations of the division under this chapter and shall fix their compensation."

By the beginning of the 1950-51 fiscal year, the staff of the Division of Mines amounted to 29 technical employees and 19 non-technical employees. Two non-technical employees were added during the 1949-50 fiscal year.

Of the total number, 24 technical employees and 16 non-technical employees work in the San Francisco headquarters office. The Los Angeles branch office will, during the 1950-51 fiscal year, maintain a staff of 4 technical employees (after transfer of one from the San Francisco office) and 1 non-technical employee. The Redding district has a staff of 1 technical and 1 non-technical employee. It also maintains space for the field division of the cooperative program of work with the United States Geological Survey. The Sacramento office was removed during August

1950 from 631 J Street to the State Office Building No. 1 where public service information can be given more effectively. One non-technical employee will continue to work in that office. Various members of the technical staff from the headquarters office are occasionally in the Sacramento office, but the preparation of technical reports will be done in San Francisco where there are available equipment, laboratories, a working set of minerals and rocks, and a splendid technical library, and the field will be reached from this central office.

Once a month the entire technical staff meets in the headquarters office of San Francisco and benefits by mutual interchange of information gained through field surveys and other research studies. Integration and coordination of the work are thus made possible. Supervision of all the projects is therefore centralized; in this manner greater efficiency is maintained in the administration of the work, which results in improved service to the public.

FINANCIAL STATEMENT

Fiscal 1949-1950 *

Total salaries and wages		$184,019.16
Operating expenses:		
Freight, cartage, and express	$1,066.64	
Telephone and telegraph	2,491.44	
Light, heat, and power	1,179.59	
Rent of building space	19,158.47	
Rent of equipment	3.75	
Repairs and maintenance of structures and other facilities	4,489.51	
Office supplies and services	4,482.37	
Postage	4,079.77	
Photography supplies and services	952.16	
Blueprinting	368.31	
Printing bulletins and maps	59,187.53	
Printing, general	1,772.96	
Technical reports	10,000.00	
Auto parts and services	2,388.43	
Auto-gas, oil, tires and tubes	2,604.83	
Travel	9,380.35	
Auto mileage	99.46	
Laboratory supplies and services including assays	3,123.88	
Library supplies and services	884.85	
Exhibits supplies and services	415.90	
Total operating expenses		128,130.20
Equipment:		
Automobile	$137.17	
Field	580.86	
Laboratory	3,796.11	
Library	1,395.43	
Exhibits	234.48	
Office	4,590.91	
Total equipment		10,734.96
Total expenditures		$322,884.32
Special item: Geological exploration in cooperation with U. S. Geological Survey		50,000.00
Grand total		$372,884.32

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* Some of the figures given are approximate, because not all bills for the fiscal year were paid at the time this report was prepared.

INFORMATION SERVICE

Public Resources Code:

> "2202. The State Mineralogist shall maintain offices, and a museum, library, and laboratory in San Francisco for the purposes provided in this chapter."
>
> "2205. The State Mineralogist shall: . . . (g) Maintain, in effect, a bureau of information concerning the mineral industry of this State. . ."

By means of its publications, the Division of Mines is able to give authentic information to the greatest number of people. There is also, however, constant demand for information made by persons who call at the offices or who write letters of inquiry. Much of the time of every member of the staff is devoted to giving oral information or to writing letters. Two mining geologists are occupied full-time in the main information room at the San Francisco office. In the three district offices this same service for the public is maintained, but on a smaller scale.

To operating mining companies and prospective operators information is given on locations of existing deposits, published and unpublished mining and geologic reports, locations of mills and mineral processing plants, locations of mineral markets, statistical data on mineral production, references to published statutes and other published laws affecting the mining industry, and services provided by other governmental agencies. Division of Mines maps and reports are available at the information counters, either for reference or for purchase.

To prospectors, information is given on possible locations of mineral occurrences, processing methods, methods of locating and holding mining claims, mining methods, sources of mining machinery and commercial technical services, methods of processing minerals, and market outlets for mineral products. A monthly posting is made in all four offices of the Division of mineral deposits wanted or offered for sale.

Professional geologists and mining engineers are given information on references in the literature on specific mineral problems, and assistance in assembling data on mining history, as well as all available statistics on mineral uses.

To many other persons, such as lapidaries, mineral collectors, and students, information is given on mineral localities and names of common minerals and rocks. Any visitor may be shown specimens of particular minerals and rocks about which he is inquiring in the large exhibit of the Division, and explanations are given concerning the natural associations of various minerals and rocks.

At the San Francisco office approximately 18,600 persons obtained such information during the 1949-50 fiscal year, an average of 1,550 per month. Requests for information by telephone are as numerous as personal calls. In addition, several classes of school children, amounting in all to several hundred, visit the mineral exhibit each month. At the San Francisco office an average of 1,500 pieces of mail requiring an answer was received each month, and many of these were requests for the same type of information as given orally.

At the Los Angeles office the number of visitors generally amounts to 500 to 600 per month, but reached a peak of 1,147 in March 1950. Telephone calls reached a peak of 1,349 in June 1950 on account of inquiries concerning assessment work on mining claims. Totals for the fiscal year were 7,605 oral interviews, 7,362 telephone calls, and 1,579 letters written.

At Sacramento the totals for the year were 896 oral interviews, 609 telephone inquiries, and 1,521 pieces of mail sent out.

At Redding the totals were 837 oral interviews, 456 telephone calls, and 339 letters written.

PUBLIC APPEARANCES

Throughout the fiscal year various members of the technical staff have by request appeared before public gatherings to give information concerning mineral resources, geology, and other subjects. Use has been made of pictures taken by members of the staff during their survey work. Projection of kodachrome illustrations has proved very effective. Technical motion pictures obtained from the U. S. Bureau of Mines and various industrial concerns have also proved to be very popular. The following summary shows to what extent this service was extended to the public during the 1949-50 fiscal year.

Name of public gathering	Number of appearances of staff members
Technical Groups	
American Institute of Mining and Metallurgical Engineers, San Francisco and Los Angeles	13
Western Chemical Market Research Group	7
American Ceramic Society, San Francisco and Los Angeles	4
American Association of Petroleum Geologists, San Francisco and Los Angeles	4
Geological Society of America, El Paso and Seattle	2
Pacific Chemical Society	1
Chambers of Commerce	
San Francisco Chamber of Commerce Mining Committee	10
Los Angeles Chamber of Commerce Mining Committee	10
Commonwealth Club of California	3
Riverside County Chamber of Mines	1
Mining Groups	
Hydraulic Miners Association	3
Western Mining Council	2
American Mining Congress, Spokane	1
Colfax Hydraulic Miners Association	1
Prospectors Institute, Mining Association of the Southwest	1
Mother Lode Mining Association	1
Fairs	
California State Fair	Appearances continuous or frequent throughout duration of fair
Electronics Exposition, San Francisco	
Butte County Fair	
Kern County Fair	
Lassen County Fair	
Nevada County Fair	
San Bernardino County Fair	
San Diego County Fair	
Shasta County Fair	
Trinity County Fair	
Mineral and Geological Societies	
Northern California Geological Society	48
Northern California Mineral Society	4
Rift Club	3
Branner Geological Society	3
Sacramento Geological Society	2

Name of public gathering	Number of appearances of staff members
San Jose Lapidary Society	2
Lassen Mineral Society	1
San Fernando Valley Gem and Mineral Society	1
Orange Coast Mineral and Lapidary Society	1
Monterey Bay Mineral Society	1
Le Conte Club	1
Sacramento Mineral Society	1
Santa Cruz Mineral Society	1
East Bay Mineral Society	1
Delvers Honorary Geological Society	1
Gem and Mineral Society of San Mateo County	1
Delvers Gem and Mineral Society, Downey	1
Castro Valley Mineral and Gem Society	1

Educational

Southern California Junior College Association, Earth Science Section	1
North Hollywood Evening High School	1
Palo Alto High School geology class	2
Delta P.T.A.	1
Roosevelt Junior High School, Oakland	1
Sacramento school	1
Montana School of Mines dinner meeting, Sacramento	1
Redding teachers science study group	1
Audio-Visual Education Association spring conference	1
San Jose State College conservation class	1
Conservation Education Committee of Natural Resources	4
First Regional Conservation Conference, Pasadena	1
Conservation education classroom appearances	3
Motion pictures loaned and shown (7 films available)	81

Miscellaneous

Tri-County Park & Planning Commission, Folsom	1
Sixth Agricultural District, Exposition Park, Los Angeles (Mineral exhibit)	1
San Francisco Optimists Club	1
Shasta County Historical Society	1
Fire Prevention Committee of Natural Resources	1

The above list includes meetings attended, talks given, technical motion pictures shown, participation in committees and conferences and panel discussions, assisting in mineral identification and setting up mineral exhibits, and judging mineral exhibits.

MINERAL LABORATORY

Public Resources Code:

> **"2202. The State Mineralogist shall maintain offices, and a . . . laboratory in San Francisco for the purposes provided in this chapter."**

During the fiscal year 1949-50, 3,392 samples were received and reported on by the laboratory of the Division of Mines. This is an increase of 7 percent over the preceding fiscal year of 1948-49. Although there was not the increase in total number of samples that was expected, there was an increase in the number of nonmetallic samples and inquiries for information relative to the commercial possibilities of these raw materials. Also, with the discoveries of jadeite in California, a large number of jade-like minerals and other semi-precious materials were received for identification and classification.

Interest was still maintained in radioactive materials. This is well indicated by the constant demand for the testing of rocks and ore samples for uranium, thorium, and other radioactive materials.

The spectrographic laboratory unit was completed and is now in operation. Considerable time was spent setting up the laboratory and calibrating the spectrograph. However, the actual calibration of the instrument was accomplished by securing the help of Mr. George Gordon, spectrographer with the Division of Mineral Technology, University of California. An associate mining geologist and two junior mining geologists completed a course of study of Spectrochemical Analysis at the University of California, and they are now able to operate the spectrograph and obtain satisfactory results.

The photographic laboratory was completed and various kinds of equipment and supplies were installed. Staff members, who are familiar with photographic laboratory techniques, are now taking advantage of this laboratory service and are processing their own film and making prints for future Division publications.

Much use was made of the petrographic laboratory by staff geologists who are carrying on active studies of mineral commodities in California.

MINERAL EXHIBITS

Public Resources Code:

"2202. The State Mineralogist shall maintain offices, and a museum . . . in San Francisco for the purposes provided in this chapter."

"2205. The State Mineralogist shall: . . .

(c) Make a collection of typical geological and mineralogical specimens, especially those of economic and commercial importance, such collection constituting the museum of the division.

(e) Make a collection of models, drawings, and descriptions of the mechanical appliances used in mining and metallurgical processes."

"2206. The State Mineralogist may prepare a special collection of ores and minerals of California to be sent to or used at any world's fair or exposition in order to display the mineral wealth of the State."

One of the most effective ways of acquainting people with the minerals and rocks of the state is to give them an opportunity to see these materials in well designed and illustrated exhibits. Fortunately, the Division of Mines has an excellent collection of minerals, ores, and rocks, which is visited daily by various groups and individuals seeking information regarding mineral commodities available in California. During the past fiscal year, considerable time was spent in the museum cleaning the exhibits, lining cases with a monkscloth background, rearranging specimens on wooden blocks, and preparing new labels.

Various staff members attended mineral shows, mining conventions, and the Pacific Chemical Expositions where they exhibited the mineral commodities of California, demonstrated the action of Geiger counters on radioactive minerals, distributed the Division's publications, and answered questions of the public.

A total of 77 sets of minerals and rocks were provided to schools throughout California.

MINERAL ACCESSIONS TO THE MUSEUM

Public Resources Code:

"2204. The State Mineralogist may receive on behalf of this State, for the use and benefit of the division, gifts, bequests, devices, and legacies of real or other property and may use the same in accordance with the wishes of the donors. If no instructions are given by the donors, the State Mineralogist shall manage, use, and dispose of the gifts, bequests, and legacies for the best interest of the division and in such manner as he may deem proper."

Many specimens were donated to the museum by interested and generous persons. Among these specimens are the following:

21359 APATITE ($(CaF)Ca_4(PO_4)_3$) with hematite. From Pershing County, Nevada. Donor: R. L. Ferdinando, July, 1949.

21360 OPAL ($SiO_2 \cdot nH_2O$), fluorescent. From Last Chance Canyon, Kern County, California: Donor: J. C. P. Skattowe, 1949.

21361 PSILOMELANE (manganese oxide). From near Redrock Canyon, Kern County, California. Donor: Kurt Wallace, 1949.

21362 APATITE ($(CaF)Ca_4(PO_4)_3$), transparent crystals. From State of Durango, Mexico. Donor: Dan Williams, 1949.

21363 EMERALD ($Be_3Al_2(SiO_3)_6$). From Columbia. Donor: Frank J. Baird, July 6, 1949.

21364 MOLYBDENITE (MoS_2) in pegmatite. From near Fawn Lodge, Trinity County, California. Donor: L. T. Allen, 1949.

21365 TROGERITE ($(UO_2)_3(AsO_4)_2 \cdot 12H_2O$). From Green River, Utah. Donor: John Maxwell, November, 1949.

21366 AUTUNITE ($Ca(UO_2)_2(PO_4)_2 \cdot 8\text{-}12H_2O$). From Marysville, Utah. Donor: C. R. Redington, December 29, 1949.

21367 URANINITE (PO_2, between UO_2 and U_3O_8, with U^4 predominant). From Chaffee County, Colorado. Donor: R. R. Redington, December 29, 1949.

21368 TORBERNITE ($Cu(UO_2)_2(PO_4)_2 \cdot 8\text{-}12H_2O$), in sandstone. From Park County, Colorado. Donor: R. R. Redington, December 29, 1949.

21369 ALTAITE ($PbTe$) in carbonaceous shale. From Hilltop Mine, Oregon, New Mexico. Donor: R. R. Redington, December 29, 1949.

21370 ALTAITE ($PbTe$) in dolomite. From Hilltop Mine, Oregon, New Mexico. Donor: R. R. Redington, December 29, 1949.

21371 FLUORESCENT WOOD. From Red Center Mine, La Salle Mountains, Utah. Donor: R. R. Redington, December 29, 1949.

21372 PETRIFIED WOOD, covered in places with crystals of manganite ($Mn_2O_3 \cdot H_2O$) and small yellow crystals of carnotite ($K(UO_2)(VO_4) \cdot \frac{1}{2}\text{-}1\frac{1}{2}H_2O$). From Cameron, Arizona. Donor: Maggie and Riley Baker, 1950.

21373 MANGANITE ($Mn_2O_3 \cdot H_2O$) crystals on quartzite. From Arizona. Donor: C. A. Noren, January 10, 1950.

21374 MANGANITE ($Mn_2O_3 \cdot H_2O$) crystals on quartzite. From Arizona. Donor: C. A. Noren, January 10, 1950.

21375 PEROVSKITE ($CaTiO_3$), crystals on metamorphosed serpentine. From near the Gem Mine, San Benito County, California. Donor: Buck Bleifus, February 1950.

21376 MAGNETITE ($FeO \cdot Fe_2O_3$), in cubic and octahedral crystals on metamorphosed serpentine. From near the Gem Mine, San Benito County, California. Donor: Buck Bleifus, February 1950.

21377 ILMENITE ($FeTiO_4$), crystals with magnetite on metamorphosed serpentine. From near the Gem Mine, San Benito County, California. Donor: Buck Bleifus, February 1950.

21378 QUARTZ (SiO_2), colored green by diopside and nickel. From Panamint Valley, Inyo County, California. Donor: Eugene Bacchi, February 1950.

21379 JADE (var. jadeite, ($NaAl(SiO_3)_2$). From Upper Burma. Donor: Chang Wen Ti, February 1950.

21380 JADE (var. nephrite, ($CaMg_3(SiO_3)_4$). From Wyoming. Donor: Chang Wen Ti, February 1950.

21381 COLEMANITE ($Ca_2B_6O_{11} \cdot 5H_2O$). From Death Valley, Inyo County, California. Donor: R. F. Henley, April 11, 1950.

21382 OPAL ($SiO_2 \cdot nH_2O$), fluorescent and slightly radioactive. From Last Chance Canyon, Kern County, California. Donor: R. F. Henley, April 11, 1950.

21383 CALCITE ($CaCO_3$), coarsely crystalline. From West End Quarry, Inyo County, California. Donor: R. F. Henley, April 11, 1950.

21384 OPAL ($SiO_2 \cdot H_2O$). From Klamath Falls, Oregon. Donor: R. F. Henley, 1950.

21385 HYALITE ($SiO_2 \cdot nH_2O$), a variety of opal. From 30 miles south of Delta, Utah. Donor: Charles J. Hansen, May 1950.

21386 TOURMALINE (a complex silicate of boron and aluminum), with specular hematite and magnetite. From Arroyo Martels, Baja California. Donor: R. L. Ferdinando, May 22, 1950.

21387 JADE (var. jadeite, ($NaAl(SiO_3)_2$). From Clear Creek, San Benito County, California. Donor: R. F. Henley, March 11, 1950.

LIBRARY

Public Resources Code:

> "2205. The State Mineralogist shall: . . .
>
> (d) Provide a library of books, reports, and drawings bearing upon the mineral industries, the sciences of mineralogy and geology, and the arts of mining and metallurgy, such library constituting the library of the division.
>
> (e) Make a collection of models, drawings, and descriptions of the mechanical appliances used in mining and metallurgical processes.
>
> (f) Preserve and so maintain such collections and library as to make them available for reference and examination, and open to public inspection at reasonable hours.
>
> (g) Maintain, in effect, a bureau of information concerning the mineral industry of this State to consist of such collections and library, and arrange, classify, catalogue, and index the data therein contained, in a manner to make the information available to those desiring it."

The value of a fine technical library kept up to date, attended by a librarian trained in geology, and made available to the public cannot be overestimated. The Division of Mines maintains such a library, particularly useful in helping to develop the mineral industry of California. As in the past, it is planned to continue to improve the library by adding new books and arranging them in a manner most readily accessible to the staff and to the attendants who serve the public.

During the 1949-50 fiscal year 330 new books were added (127 by donation, 25 by exchange, 178 by purchase) in contrast with a total of 226 of the previous fiscal year. The total of classified books in the library now amounts to over 8000.

A room has been added for research study, which is well lighted and provided with an adequate table and chairs. In addition to the library and this research room there is a reading room in which are located the current trade magazines. The library subscribes to nearly 50 technical publications and about 40 periodicals are received on exchange. Carnegie publications have been added to the library in the amount of 25 reports, and about 75 maps and charts, largely from the Federal Geological Survey. These serials and miscellaneous publications added during the last fiscal year amount to about 10 percent over what was added during the previous year.

The work of the library is closely coordinated with the educational division of the Department of Natural Resources. In this work over a hundred teachers' kits (consisting of general information and publications of interest to schools) have been distributed.

During the fiscal year the library had 2726 visitors in contrast with 1344 of the 1948-49 fiscal year. The visitors in the reading room amounted to 1600 in contrast to 1560 of the former fiscal year. Special assistance was given in connection with research work to 1458 persons in contrast to 766 of the previous fiscal year.

Through visits to other libraries and making frequent public appearances, where publications are displayed and motion pictures shown, the librarian has contributed to the mineral service of the Division. The publications of the Division are now exchanged with 264 organizations and agencies and supplied to an additional list of 259 libraries. Interlibrary loans amounted to 16.

Books Added to the Library, Fiscal Year 1949-50
(D-Donation; E-Exchange)

Aitken, A. C., Statistical mathematics, 5th ed., Edinburgh, Oliver and Boyd, 1947.

(E) American Bureau of Metal Statistics Yearbook, 28th annual issue, 1948.

(D) American Institute of Mining and Metallurgical Engineers, Industrial minerals and rocks, 2d ed., 1949.

(D) American Institute of Mining and Metallurgical Engineers, Production of Petroleum in 1923.

(D) American Institute of Mining and Metallurgical Engineers, Trans., vols. XVI to XXVIII, 1887-98.

(D) American Institute of Mining and Metallurgical Engineers, Contents and index, Trans., vols. XXI to XXV, 1897.

(D) American Institute of Mining and Metallurgical Engineers, Trans., Copper Metallurgy, vol. 106, 1933.

(D) American Institute of Mining and Metallurgical Engineers, Trans., Petroleum development and technology, vol. 118, 1936.

(D) American Institute of Mining and Metallurgical Engineers, Trans., Metallurgy of lead and zinc, vol. 121, 1936.

(D) American Institute of Mining and Metallurgical Engineers, Trans., Petroleum development and technology, vol. 123, 1937.

(D) American Institute of Mining and Metallurgical Engineers, Trans., Petroleum technology and development, vol. 127, 1938.

(D) American Institute of Mining and Metallurgical Engineers, Trans., Institute of Metals Division, vol. 156, 1944.

(D) American Institute of Mining and Metallurgical Engineers, Trans., Iron and Steel Division, vol. 158, 1944.

(E) American Institute of Mining and Metallurgical Engineers, Trans., Coal Division, vol. 177, 1948.

(D) American Institute of Mining and Metallurgical Engineers, Trans., Institute of Metals Division, Iron and Steel Division, and Extractive Metallurgy Division, vol. 185, 1949.

(D) American Institute of Mining and Metallurgical Engineers, Trans., Petroleum development and technology, vol. 186, 1949.

(D) American men of science, 4th ed., Science Press, c. 1927.

(D) American men of science, edited by J. McKeen Cattell and Jacques Cattell, 5th ed., Science Press, c. 1933.

(D) American men of science, 7th ed., Science Press, c. 1944.

American men of science, 8th ed., Science Press, c. 1949.

(D) American Petroleum Institute, Drilling and production practice, 1936.

American Society for Testing Materials, A.S.T.M. Standards on ferrous metals, non-ferrous metals, cement, ceramics, textiles, petroleum, c. 1950.

(D) Axelrod, Daniel I., A Miocene flora from the western border of the Mohave Desert: Carnegie Inst. Washington. Publ. 516, 1939.

Ball, Sydney H., A Roman book on precious stones, Los Angeles, Gemol. Inst. America, c. 1950.

Barksdale, Jelks, Titanium—its occurrence, chemistry, and technology, Ronald Press, 1949.

Bateman, Alan M., Economic mineral deposits, 2d ed., John Wiley & Sons, c. 1950.

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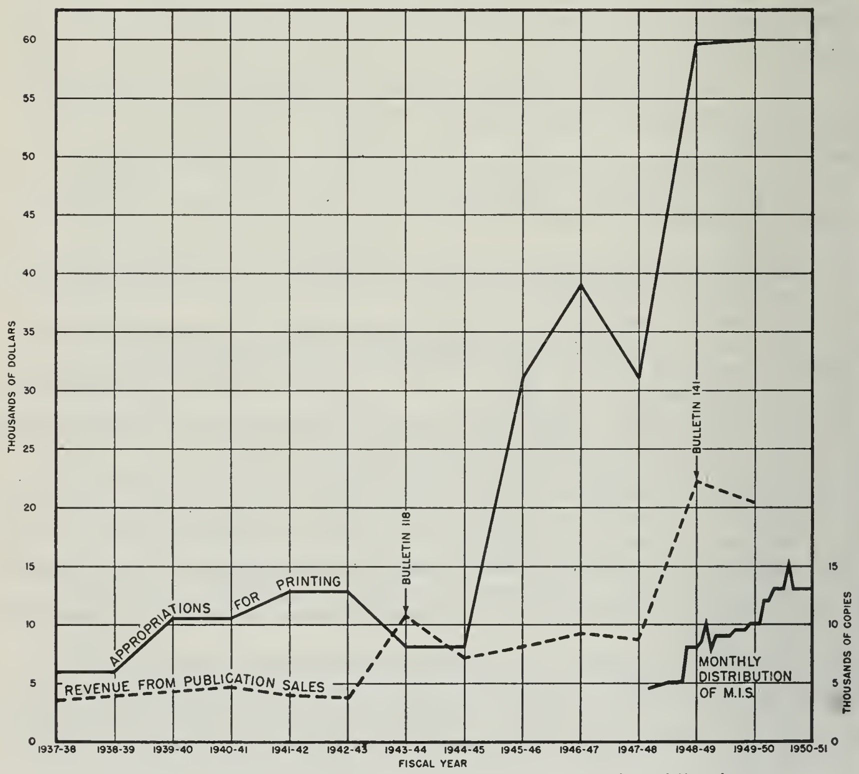


FIGURE 1. Graph showing growth of public interest in publications of the Division of Mines, 1937-1950.

(E) Zapffe, Carl, A review of iron bearing deposits in Washington, Oregon, and Idaho, Portland, Oregon, Raw Materials Survey Rept. 5, 1949.

Zimmerman, O. T., and Lavine, Irvin, Scientific and technical abbreviations, signs, and symbols, 2d ed., Dover, New Hampshire, Independent Research Service, 1949.

PUBLICATIONS BY THE DIVISION OF MINES

> Public Resources Code:
>
> "2205. The State Mineralogist shall: . . . (h) Issue from time to time such bulletins as he may deem advisable concerning the statistics and technology of the mineral industries of this State."
>
> "2209. The State Mineralogist may fix a price upon and dispose of to the public all publications of the division, including reports, bulletins, maps, registers, or other publications. The price shall approximate the cost of publication and distribution. He may also furnish the publications of the division to public libraries without cost and may exchange publications with geological surveys, scientific societies, and other like bodies.
>
> "2210. All money received by the division from sales of publications issued by the division shall be deposited at least once each month in the State treasury to the credit of the General Fund . . ."

The Division of Mines issued a large number of publications during the 1949-50 fiscal year. The types of publications consisted of the following: *Mineral Information Service* (a monthly pamphlet), *California Journal of Mines and Geology* (a quarterly publication), *Bulletins* (occasional monographs or statewide treatises). Occasionally a particular paper becomes very much in demand and must be reprinted, or a supplement is issued separately.

A new type of publication has now been started, known as the *Special Report*. Although several of these have been prepared, the publication of them will start in the 1950-51 fiscal year. The *Special Reports* will consist of shorter technical papers which are not suitable for a bulletin and which have heretofore overcrowded the *California Journal of Mines and Geology.*

In *Mineral Information Service* are published the latest statistical information on the mineral production of California and other data which should be distributed to the public without delay, such as new discoveries, new laws, rules concerning assessment work, and announcement of new and available publications. Brief discussions of important mineral commodities are included in this pamphlet, which the public may receive without charge upon request. Mineral Information Service has proved to be the most popular publication of the Division and many letters of favorable comment have been received concerning it.

The June 1, 1950 issue was mailed to 10,033 (including 303 foreign) in comparison to a 6,846 mailing at the beginning of this fiscal year (July 1, 1949 issue). As a result of issuing this pamphlet the sales of publications have reached quite a high point. During the 1949-50 fiscal year the receipts for publication sales amount to $20,261. Although this is slightly less than the previous fiscal year ($22,576), it did not have the benefit of any special semi-technical book to bring the sales up. The condition shows that the more technical publications are now receiving much wider attention. Bulletin 141, the Mother Lode guidebook, went through two printings and increased the sales of the Division to a higher point than ever before. It is contemplated that during the next fiscal year there will be an unusually large sale since several additional semitechnical books will be issued: (1) *San Francisco Geologic Guidebook;* (2) *Mineral Commodities of California;* (3) *Minerals Useful to Agriculture,* and (4) *Evolution of California's Landscape.*

Reports Published by the Division of Mines
Fiscal 1949-1950

SDM—Papers by staff members of State Division of Mines
GS—Papers by U. S. Geological Survey
BM—Papers by U. S. Bureau of Mines
C—Papers contributed or purchased from consultants, etc.
U—Papers contributed or purchased from University personnel

MINERAL INFORMATION SERVICE

Vol. 2, no. 7: Alum and alum minerals; Mineral needs and problems of the fertilizer industry; Colusa County
8: Gallium; Contra Costa County; Uranium; Gold, silver, copper, lead, zinc production in California, 1948
9: Mineral needs, glass container industry in California; Iodine; Del Norte County; Borates
10: El Dorado County; Ferro-alloys; Petroleum production, utilization, comparison 1948-49; Map showing distribution of principal mineral resources of California
11: Lead; Chromium
12: Quartz; Index to *Mineral Information Service*, vols. 1, 2
Vol. 3, no. 1: Use of mill tailings for filling; Mineral needs and problems of the petroleum industry; Quantity and value of mineral substances produced in California during 1946, 1947, 1948; Mineral production 1947-48, by counties
2: Pyrophyllite; Manganese; Mine production gold, silver, copper, lead, zinc in California, 1949; Gold
3: California mineral production, 1949; Circularization card; Monazite and the rare-earth minerals; Zirconium
4: California chlorine-caustic industry; Gem minerals
5: Post-war developments in California cement industry; Fluorite; California sandblasting minerals
6: Tungsten; Sulfur

CALIFORNIA JOURNAL OF MINES AND GEOLOGY

CALIFORNIA JOURNAL OF MINES AND GEOLOGY, vol. 45, no. 3, July 1949, containing: Water-flooding as a method of increasing California oil production (Part 2, A survey of California conditions relative to the application of water-flooding, by Wilbur H. Somerton (U); Mines and mineral resources of Butte County, California, by J. C. O'Brien (SDM); Roofing granules in the southwest, by Stuart H. Ingram (C); The western pulp and paper industry as a consumer of chemicals, by R. G. Mispley (C); Mining law in recent years, by William E. Colby (C); Ione-Carbondale clays, Amador County, California, by F. T. Johnson and Spangler Ricker (BM); Address of Governor Earl Warren to the American Institute of Mining and Metallurgical Engineers, Inc., San Francisco, California, February 14, 1949.

CALIFORNIA JOURNAL OF MINES AND GEOLOGY, vol. 45, no. 4, October 1949, containing: Geology of limestone near Sonora, Tuolumne County, California, by George R. Heyl and John H. Wiese (GS); Geology of limestone near Gazelle, Siskiyou County, California, by George R. Heyl and George W. Walker (GS); Minerals of California—supplement no. 1 to Bulletin 136, by Joseph Murdoch (U); Water-flooding as a method of increasing California Oil production (Part 3, Current and proposed water-flooding research in California), by Wilbur H. Somerton (U); Materials of inorganic mineral origin used in the publications issued May 1, 1949 to October 1, 1949; Index to volume 45; Supplement—The elephant as they saw it, by E. L. Egenhoff (SDM).

CALIFORNIA JOURNAL OF MINES AND GEOLOGY, vol. 46, no. 1, January 1950, containing: Submarine phosphorite deposits of California and Mexico, by K. O. Emery and R. S. Dietz (U); Geology along the Electra and West Point tunnels, Amador County, California, by John H. Wiese, Arvid A. Stromquist, John H. Eric, and C. Melvin Swinney (GS); Geology and tungsten deposits of the Tungsten Hills, Inyo County, California, by Paul C. Bateman, Max P. Erickson, and Paul D. Proctor (GS); Geology of the Placerita oil field, Los Angeles County, California, by Gordon B. Oakeshott (SDM); Perlite deposits of Sonoma County, California, by Charles W. Chesterman (SDM); Mines and mineral resources of Sonoma County, California, by Martin T. Honke Jr. and William E. Ver Planck Jr. (SDM); Annual report of the State Mineralogist, Chief of the Division of Mines for the one-hundredth fiscal year, July 1, 1948 to June 30, 1949, by Olaf P. Jenkins (SDM).

CALIFORNIA JOURNAL OF MINES AND GEOLOGY, vol. 46, no. 2, April 1950, containing: Geology and oil prospects of western San Jose Hills, Los Angeles County, California, by Franklin H. Olmsted (U); Ironstone concretions and beach ridges of San Diego County, California, by K. O. Emery (U); Geology of the Red Mountain magnesite district, Santa Clara and Stanislaus Counties, California, by Alfred J. Bodenlos (GS); Mines and mineral resources of Alameda County, by Fenelon F. Davis (SDM); Supplement—Manner of locating and holding mineral claims in California, by A. H. Ricketts, revised by C. A. Logan and Charles V. Averill (SDM).

SUPPLEMENTS DISTRIBUTED SEPARATELY

THE ELEPHANT AS THEY SAW IT, by Elisabeth L. Egenhoff, supplement to the October 1949 California Journal of Mines and Geology.

MANNER OF LOCATING AND HOLDING MINERAL CLAIMS IN CALIFORNIA, by A. H. Ricketts, revised by C. A. Logan and Charles V. Averill (SDM).

BULLETINS

Bulletin 142—THE COUNTIES OF CALIFORNIA—MINERAL RESOURCES AND MINERAL PRODUCTION DURING 1947, prepared under the direction of Olaf P. Jenkins, contributing authors Charles V. Averill, Oliver E. Bowen Jr., Fenelon F. Davis, Clarence A. Logan, Lewis A. Norman Jr., John C. O'Brien, Reid J. Sampson, Richard M. Stewart, Henry H. Symons, William E. Ver Planck Jr. (SDM).

Bulletin 147—GEOLOGY OF THE QUIEN SABE QUADRANGLE, CALIFORNIA, containing: Geology of the Quien Sabe quadrangle, California, by Carlton James Leith (U); Quicksilver and antimony deposits of the Stayton district, California, by Edgar H. Bailey and W. Bradley Myers (GS).

Bulletin 148—GEOLOGY OF THE BLUE LAKE QUADRANGLE, CALIFORNIA, by George A. Manning and Burdette A. Ogle (U—report only).

Bulletin 149—GEOLOGY AND MINERAL DEPOSITS OF AN AREA NORTH OF SAN FRANCISCO BAY, CALIFORNIA—Vacaville, Antioch, Mount Vaca, Carquinez, Mare Island, Sonoma, Santa Rosa, Petaluma, and Point Reyes quadrangles, by Charles E. Weaver (U).

Bulletin 151—GEOLOGY OF THE MACDOEL QUADRANGLE, CALIFORNIA, containing: Geology of the Macdoel quadrangle, California, by Howel Williams (U); Circular soil structures in northeastern California, by Peter H. Masson (U).

Bulletin 152—GEOLOGIC DESCRIPTION OF THE MANGANESE DEPOSITS OF CALIFORNIA, supplement to Bulletin 125, by Parker D. Trask and others (GS).

Bulletin 153—GEOLOGY OF THE NEENACH QUADRANGLE, by John H. Wiese (U—report only).

REPORTS IN PRESS June 30, 1950.

CALIFORNIA JOURNAL OF MINES AND GEOLOGY, vol. 46, no. 3, July 1950, containing: Geology of the Needles magnesite deposit, San Bernardino County, California, by Charles J. Vitaliano (GS); Northern California as a market for chemicals, by E. William Eipper (C); Skaggs Springs quicksilver mine, Sonoma County, California, by Donald L. Everhart (GS); Altoona quicksilver mine, Trinity County, by C. M. Swinney (BS); Health and safety work of the Bureau of Mines, by James Boyd (BM); Mines and mineral resources of Yolo County, by J. C. O'Brien (SDM).

CALIFORNIA JOURNAL OF MINES AND GEOLOGY, vol. 46, no. 4, October 1950, containing: Quicksilver deposits of the Cachuma district, Santa Barbara

County, California, by Donald L. Everhart (GS); Mines and mineral resources of Madera County, California, by C. A. Logan (SDM); Mining law in recent years, by William E. Colby (C).

SPECIAL REPORT 1A—SIERRA BLANCA LIMESTONE FROM SANTA BARBARA COUNTY, CALIFORNIA, by George W. Walker (GS).

SPECIAL REPORT 1B—THE CALERA LIMESTONE IN SAN MATEO AND SANTA CLARA COUNTIES, CALIFORNIA, by George W. Walker (GS).

SPECIAL REPORT 2—GEOLOGY OF PART OF THE DELTA-MENDOTA CANAL NEAR TRACY, CALIFORNIA, by Parry Reiche (C).

Bulletin 134, Part 1, Chapter 2—CHROMITE DEPOSITS OF SISKIYOU COUNTY, CALIFORNIA, by Francis G. Wells and Fred W. Cater Jr. (GS).

Bulletin 150—GEOLOGY OF SOUTHWESTERN SANTA BARBARA COUNTY, Point Arguello, Lompoc, Point Conception, Los Olivos, and Gaviota quadrangles, by T. W. Dibblee Jr. (C).

Bulletin 156—MINERAL COMMODITIES OF CALIFORNIA, by the staff of the State Division of Mines.

Bulletin 157—GEOLOGY OF SAN JOSE-MT. HAMILTON AREA, by Max D. Crittenden (U).

REPORTS AVAILABLE FOR PROCESSING June 30, 1950

Limestone in the beet-sugar industry, by F. H. Ballou, Jr. (C).
Dimension stone, San Diego County, California, by Richard A. Hoppin and L. A. Norman Jr. (U, SDM).
Geology of the San Dieguito pyrophyllite area, San Diego County, California, by Richard H. Jahns and John F. Lance (U).
A study of hydraulic-filling in metal-mines, by William E. Lightfoot (U).
Type Moreno formation and overlying Eocene strata on the west side of San Joaquin Valley, Fresno and Merced Counties, by Max B. Payne (C).
Mineral surface energy and the thermodynamic efficiency of comminution, by A. K. Schellinger (U).
Geology of the Bitterwater Creek area, northwest Kern County, California, by Henry H. Heikkila and George M. MacLeod (C).
The evolution of California's landscape, by N. E. A. Hinds (U).
Geology of the Cuyamaca Peak quadrangle, by D. L. Everhart (U).
Occurrence of ground water in bedrock in western San Diego County, by Richard Merriam (U).
Geology of the Corona, Elsinore, and San Luis Rey quadrangles of southern California, by E. S. Larsen (U).
Geology of the Saltdale quadrangle, California, by T. W. Dibblee Jr. (C).
Geology of the Healdsburg quadrangle, California, by William K. Gealey (U).
Mineralogy of the California glaucophane schists, by George Switzer (C).
The pegmatites of the Pala gem and lithium district, San Diego County, California, by Richard H. Jahns (U) and Lauren A. Wright (SDM).
Geology and ore deposits of the Shasta gold district, by V. F. Hollister (U).
Pumice and pumicite, by F. Sommer Schmidt (C).
Minerals useful in agriculture, by Hans Jenny, W. E. Ver Planck Jr., Robert Z. Rollins, Oliver E. Bowen Jr., James W. Vernon, Lauren A. Wright (U, C, SDM).
Geologic guidebook of the San Francisco Bay Counties, by Dorothy G. Jenkins, Arthur Howard, Erwin G. Gudde, Robert F. Heizer, Adan Treganza, J. N. Bowman, G. Dallas Hanna, Richard A. Crippen Jr., V. L. VanderHoof, Perry Byerly, N. L. Taliaferro, R. A. Stirton, Ralph W. Chaney, Leo G. Hertlein, Oliver E. Bowen Jr., William E. Ver Planck Jr., Francis G. Wells, Edgar H. Bailey, Gordon B. Oakeshott, Charles V. Averill, Robert Wing, Lauren A. Wright, Charles W. Chesterman, Mort D. Turner, Joseph Pask (SDM, C, GS, U).

ORE BUYERS' LICENSES AND INSPECTION

Public Resources Code:

"2250. It is unlawful for any person to engage in the business of milling, sampling, concentrating, reducing, refining, purchasing, or receiving for sale, ores, concentrates, or amalgams bearing gold or silver, gold dust, gold or silver bullion, nuggets, or specimens without first procuring the license provided for by this chapter."

> "2253. The application for a license to carry on such business shall be made to the State Mineralogist. . ."
>
> "2267. Every licensee under this chapter shall file monthly with the State Mineralogist a report of all purchases made under this chapter. The reports shall be made upon forms prescribed by the State Mineralogist and shall contain the information required by this chapter."

Ore Buyers' licenses of two kinds are issued by the Division of Mines. The limited license limits the buyer to $1,000 in purchases of gold for the calendar year. The second type carries no limit on purchases. At the end of July 1950, 49 limited licenses and 45 unlimited licenses had been issued. This is about the same number as is usually issued in a calendar year because nearly all licenses are taken out during the early part of a calendar year. For the calendar year 1949, 48 limited and 55 unlimited licenses were issued.

MINERAL STATISTICS

> Public Resources Code:
>
> "2205. The State Mineralogist shall:
>
> (a) Make, facilitate, and encourage special studies of the mineral resources and mineral industries of the State.
>
> (b) Collect statistics concerning the occurrence and production of the economically important minerals and the methods pursued in making their valuable constituents available for commercial use."
>
> "2207. The owner, lessor, lessee, agent, manager, or other person in charge of any mine of whatever kind or character within the State shall forward to the State Mineralogist, upon his request, at his office, not later than the thirty-first day of March in each year, upon forms which will be furnished, a report showing the character of the mine, the method of working the mine and the general condition thereof, and the total mineral production for the preceding calendar year. Any such person who fails to comply with the provisions of this section is guilty of a misdemeanor.
>
> Such reports shall be confidential. Other records are public records unless excepted by statute. Statistical bulletins based on these reports and published under the provisions of Section 2205 of this code shall be compiled to show, for the State as a whole and separately for each county, the total of each mineral produced therein, provided that, in order not to disclose the production of any operator, no production figure shall be published which represents the production of less than three operators; and when such production figure for any county would conflict with such provision it may be combined with such production figures for one or more other counties. Such bulletins shall be published annually by June 30th or as soon thereafter as practical."

Among producers of minerals, chambers of commerce, and many other agencies, the subject of mineral statistics is an important item. It forms the background of the study of mineral economics. The Division of Mines since 1947 has had a cooperative agreement with the Federal Bureau of Mines to gather and compile mineral statistics in California. Under this agreement the U. S. Bureau sends out all forms to producers asking for information on mineral production, while the Division furnishes names and addresses of new producers. The Division also visits the producers who are delinquent in reporting production and makes an effort to obtain the cooperation of each such producer in complying with the state law in this regard.

The compiled figures, prepared by the federal Bureau, are sent to the Division as totals by substance and by county; also by substance for each county. Where the county contains less than three producers of a

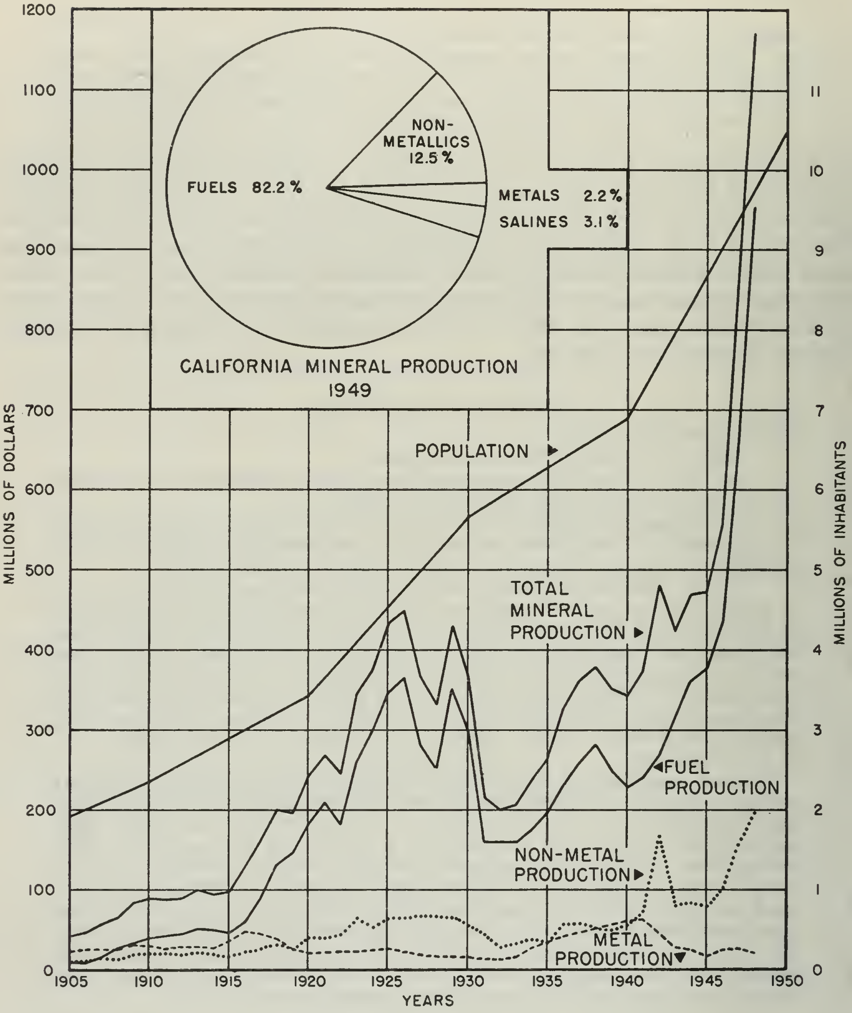


FIGURE 2. Circle graph showing comparative value of production of mineral fuels, nonmetallics, salines, and metals for the year 1949. Line-graph showing growth in mineral wealth of California from 1905-1950.

mineral substance, figures on that substance are combined with those of other counties to prevent the release of any confidential information.

The cooperative agreement has so far proved to be satisfactory. It avoids duplication of effort between the state Division and the federal Bureau; it results in securing production figures which are accurate and complete, and it avoids the discrepancies which occurred when the two agencies were collecting production figures independently.

The compilation of figures on gold, silver, lead, zinc, and copper is done in the San Francisco office of the Federal Bureau of Mines. The 1949 figures were published in the July 1950 issue of *Mineral Information Service.* Other figures are compiled by that Bureau in Washington, D. C. Data on oil and gas, however, are obtained from the State Oil and Gas Division. For this reason, not all the figures on production are available at the time when the first figures are released. In order that there will be a minimum of delay in making the information available to the public, the Division publishes these statistics, as they are completed, in its monthly pamphlet, *Mineral Information Service.*

The final assemblage of all the figures for 1947 was published in Bulletin 142, *The Counties of California, Mineral Resources and Mineral Production During 1947,* along with a general survey of the mining activities in each of the 58 counties of the state. Together with this information lists of producers, dealers, buyers, custom mills, and assay laboratories are included.

In Bulletin 156, *Mineral Commodities of California, Geologic Occurrence, Economic Development, and Utilization of the State's Mineral Resources,* to be issued late in 1950, will be the statistics for 1948 together with graphs showing production covering all previous years of activity, and a complete summary treatise on the geology, economics and operations concerning every mineral commodity (about 80) in the state.

The 1949 statistical figures, besides appearing in *Mineral Information Service,* will be assembled and published in the April 1951 issue of the *California Journal of Mines and Geology.* In this Journal will also appear the present annual report and a summary of mining activities in each county in the state.

In a forthcoming bulletin on mineral utilization and markets, not yet prepared, it is intended that the production figures will be issued and discussed from the standpoint of mineral usability. In this manner the final assemblage of production figures for each year will be published together with the other pertinent information that has formed the final results of some statewide economic surveys.

Summary of Mineral Production in California for the Years 1948 and 1949

The figures in the following list are actual for 1948 but estimated for 1949 (except for gold, silver, copper, lead and zinc) since all the data have not yet been received. Over 60 mineral commodities were produced and only those of greatest value are included in the 1949 estimate.

The decrease in the total 1949 production figures from $1,174,674,000 to $1,094,559,000, or a difference of $80,115,000, was largely due to the fluctuation in price and production of petroleum.

It is particularly significant that the total production of minerals in California has been over $1,000,000,000 for both the years 1948 and 1949.

Summary of Mineral Production in California for the Years 1948 and 1949

Mineral commodity	Recorded 1948 production		Estimated 1949 production	
	Value	Quantity	Value	Quantity
Gold	$14,751,555	421,473 fine ounces	$14,603,085	417,231 fine ounces
Silver	655,954	724,771 fine ounces	709,451	783,880 fine ounces
Copper	208,754	962,000 pounds	255,706	1,298,000 pounds
Lead	3,261,380	18,220,000 pounds	3,260,488	20,636,000 pounds
Zinc	1,416,450	10,650,000 pounds	1,787,832	14,418,000 pounds
Other metals, including chromite, iron ore, mercury, molybdenum ore, platinum metals, tungsten ore	4,213,000		3,766,000	
Petroleum	823,696,000	340,089,000 barrels	748,888,000	332,839,000 barrels
Natural gas	64,803,000	570,954,000 M cu. ft.	61,674,000	541,000,000 M cu. ft.
Natural gas gasoline	69,578,000	842,425,000 gallons	71,174,000	861,672,000 gallons
Liquefied petroleum gases	16,961,000	269,644,000 gallons	17,334,000	275,142,000 gallons
Cement	57,742,226	24,162,926 barrels	57,756,325	23,211,000 barrels
Miscellaneous stone, sand, gravel	43,748,419		41,500,000	
Clay products, heavy (other than pottery and refractories)	21,600,000		22,000,000	
Other industrial non-metallic minerals, including clay, gypsum, diatomite, lime, pumice, talc	21,714,000		16,100,000	
Salines, including borates, iodine, magnesium salts, potash, salt, sodium salts, and others	30,415,000		33,750,000	
Total value	$1,174,764,738		$1,094,558,887	

SURVEY OF MINING ACTIVITIES

Public Resources Code:

> **"2208. The State Mineralogist or a qualified assistant may at any time enter or examine any and all mines, quarries, wells, mills, reduction works, refining works, and other mineral properties or working plants in this State in order to gather data to comply with the provisions of this chapter."**

It is necessary for the Division of Mines to know of the operational activities of the mines, quarries, and other mineral development in the state since there is a constant demand by the public for this information. During the 1949-50 fiscal year, various members of the staff have been engaged in making a rapid survey of each county as regards the salient activities being carried on by operators. These reports, covering all the counties of the state, accompany this annual report. By the end of the fiscal year 1949-50 about half of the study was completed, so that the remainder of the work was carried on into the 1950-51 fiscal year.

More extensive surveys of mining activities in individual counties have been carried on for many years by the Division of Mines and published as summary reports on the mines and mineral resources of each county. The newer reports give a tabulated list of all the mines with data on ownership, references to published reports, type of deposits, accompanied by maps showing the location of the properties. During the 1949-50 fiscal year such a report on Contra Costa County was nearly completed. Another report on Inyo County was submitted for publication. Shorter reports on Yolo County, Madera County, and Fresno County were also prepared.

Reviewing this past work of the Division, it is found that of the total of 58 counties in the state, reports on the following 35 counties are old and out of date:

County	*Date of last report*
Alpine	October 1931
Calaveras	July 1936
Colusa	July 1929
Del Norte	July 1925
El Dorado	July 1938
Glenn	October 1929 (out of print)
Kings	October 1930
Lassen	October 1936
Los Angeles	July 1937
Marin	July 1926
Mariposa	April 1928 (out of print)
Mendocino	October 1929
Merced	April 1925 (out of print)
Modoc	October 1936
Mono	April 1940
Monterey	January 1925
Nevada	July 1941
Orange	January 1925
Placer	January 1936 (gold only)
Plumas	April 1937
Sacramento	January 1925
San Diego	January 1939 (out of print)
San Francisco	April 1929
San Joaquin	April 1925
San Luis Obispo	October 1935
San Mateo	April 1929
Santa Barbara	October 1925
Santa Clara	January 1930
Shasta	April 1939
Solano	April 1927
Sutter	April 1920
Trinity	January 1941
Tulare	October 1930
Ventura	July-October 1932 (out of print)
Yuba	July 1930 (out of print)

In order that the Division may be able to offer the public up-to-date summary reports on the mines and mineral resources of all the individual counties of the state, it is obvious that greater progress should be made, but this will require additional personnel.

SURVEY OF MINERAL UTILIZATION

Public Resources Code:

> "2205. The State Mineralogist shall:
>
> (a) Make, facilitate, and encourage special studies of the mineral resources and mineral industries of the State.
>
> (b) Collect statistics concerning the occurrence and production of the economically important minerals and the methods pursued in making their valuable constituents available for commercial use."

It is conceivable that if the Division of Mines were able to supply the public with adequate information concerning all the uses which various industries make of minerals, the owners of mineral deposits could find a broader market for their product, and manufacturing concerns could avail themselves of local supplies of minerals. It is the plan of the Division of Mines to make a survey of mineral utilization and to coordinate it with a study of the known and potential mineral commodities. Unfortunately the Division does not at present have a staff large enough to carry on this work adequately, but if it were in a position to do the work properly it would undoubtedly bring added wealth to the state.

Several papers were written by members of various industries and published in *Mineral Information Service* during the fiscal year 1949-1950: (1) *Mineral Needs and Problems of the Fertilizer Industry*; (2) *Mineral Needs of the Glass Container Industry of California*; (3) *Mineral Needs and Problems of the Petroleum Industry.*

Three other papers were prepared by staff members: (1) *Ferro-Alloys*; (2) *The California Chlorine-Caustic Industry*; and (3) *Post-war Developments and Conditions in the California Cement Industry.*

In addition to these papers for *Mineral Information Service*, another paper *Limestone in the California Beet Sugar Industry* was prepared for publication in the *California Journal of Mines and Geology.*

SURVEY OF MINERAL COMMODITIES

Public Resources Code:

> "2205. The State Mineralogist shall:
>
> (a) Make, facilitate, and encourage special studies of the mineral resources and mineral industries of the State."

Statewide geologic and economic surveys of individual mineral commodities represent one of the most important activities of the Division of Mines. During the 1949-50 fiscal year the entire technical staff was engaged in preparing a complete summary of all the salient features of all the known mineral commodities of California. As a result, Bulletin 156, *Mineral Commodities of California; Geologic Occurrence, Economic Development, and Utilization of the State's Mineral Resources,* will appear in the 1950-51 fiscal year. Undoubtedly it will be regarded as the most useful publication ever issued by the Division. Appearing at this time during a critical emergency when nearly all minerals are needed for national defense, the book will indeed be timely.

Work was continued on the previously initiated mineral commodity surveys of clay, gypsum, kyanite, pumice, perlite, and talc. A study of the fluorite resources of the state was begun, and plans were laid for work on various strategic minerals, including steatite.

The clay survey involved geologic mapping of deposits in the Ione area of Amador County, and detailed sampling of clays in this area and in the Alberhill area of Riverside County. The survey also included the compilation of drill core data obtained in the Buena Vista area of Amador County, and reconnaissance studies of clay deposits at numerous other localities in the state.

Gypsum deposits in the Fish Creek Mountains, Imperial County, and in Quatal Canyon, Ventura County, were mapped in detail. Reconnaissance studies were made of other gypsum deposits in the southeastern end of Cuyama Valley. Reports on the Fish Creek Mountains deposits, and on deposits in the Little Maria Mountains were prepared as part of a bulletin on the gypsum resources of California.

The study of kyanite deposits near Ogilby, Imperial County, a cooperative project with the Geology Department of the California Institute of Technology, was also continued during the year. This project too, involves the preparation of detailed geologic maps.

Perlite investigations included the mapping of deposits near Klondyke, San Bernardino County, and other deposits in the Little Chuckawalla Mountains, Riverside County. Reconnaissance maps were made of several perlite deposits in Napa and Sonoma Counties. The compilation of a bulletin on the perlite and pumice resources of California was continued.

The talc investigations were directed mainly toward the preparation of reports describing the results of previously completed field studies in the Silver Lake and southern Death Valley areas. Approximately twenty chemical analyses of commercial talcs generously contributed by producers in the state have been received.

The fluorite program, which was begun in mid-winter, included reconnaissance studies of several deposits in Kern and San Bernardino Counties. A fluorite-bearing district near Mountain Pass was mapped, and a geologic report on this area was nearly completed.

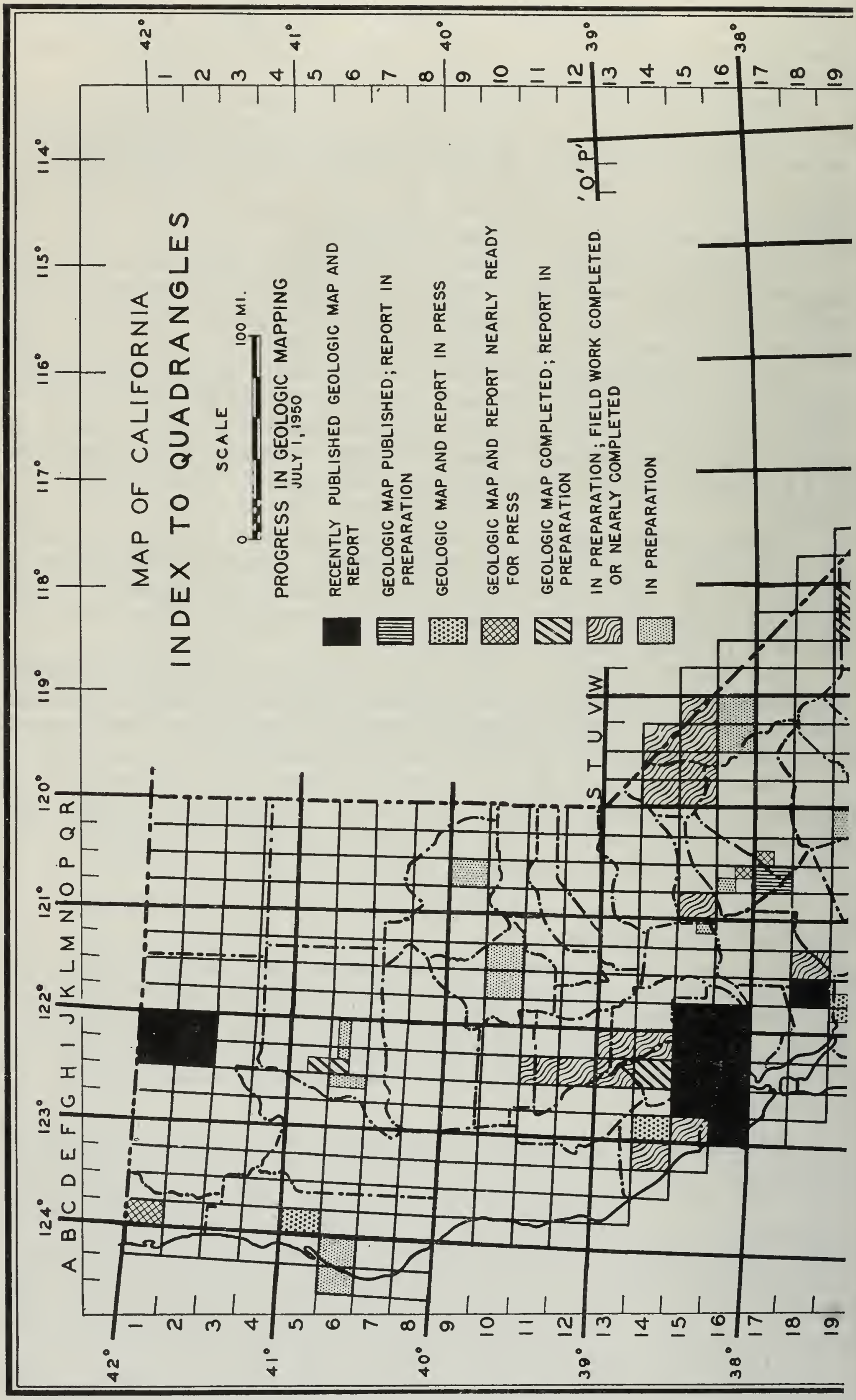
All of the field and office work described above was supplemented by laboratory investigations requiring the use of the Division's new chemical laboratory, petrographic microscopes, spectrograph, and crushing, pulverizing and screening apparatus.

CONTRIBUTIONS TO EXPLORATION FOR MINERAL FUELS

Public Resources Code:

> "2200. For the purposes of this chapter 'mine' includes all mineral-bearing properties of whatever kind or character, whether underground, quarry, pit, well, spring, or other source from which any mineral substance is or may be obtained. 'Mineral' for the purposes of this chapter includes all mineral products both metallic and nonmetallic, solid, liquid, or gaseous, and mineral waters of whatever kind or character."

The high level of activity in exploration for oil and gas established in the previous year continued during 1949-50, and was rewarded by important new discoveries and developments. Interest of exploration departments of the oil companies was extended to all provinces of the state with consequent increased demand for basic geologic information. The Division of Mines was able to supply some of this information from its *State Geologic Map,* and from its previously published reports, particularly Bulletin 118, *Geologic Formations and Economic Development of the Oil and Gas Fields of California.* New contributions by the Division included reports on the geology of twelve quadrangles, geologic reports on two petroleum-producing areas, and two papers completing a series of


MAP OF CALIFORNIA
INDEX TO QUADRANGLES
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PROGRESS IN GEOLOGIC MAPPING
JULY 1, 1950
■ RECENTLY PUBLISHED GEOLOGIC MAP AND REPORT
▤ GEOLOGIC MAP PUBLISHED; REPORT IN PREPARATION
▒ GEOLOGIC MAP AND REPORT IN PRESS
▩ GEOLOGIC MAP AND REPORT NEARLY READY FOR PRESS
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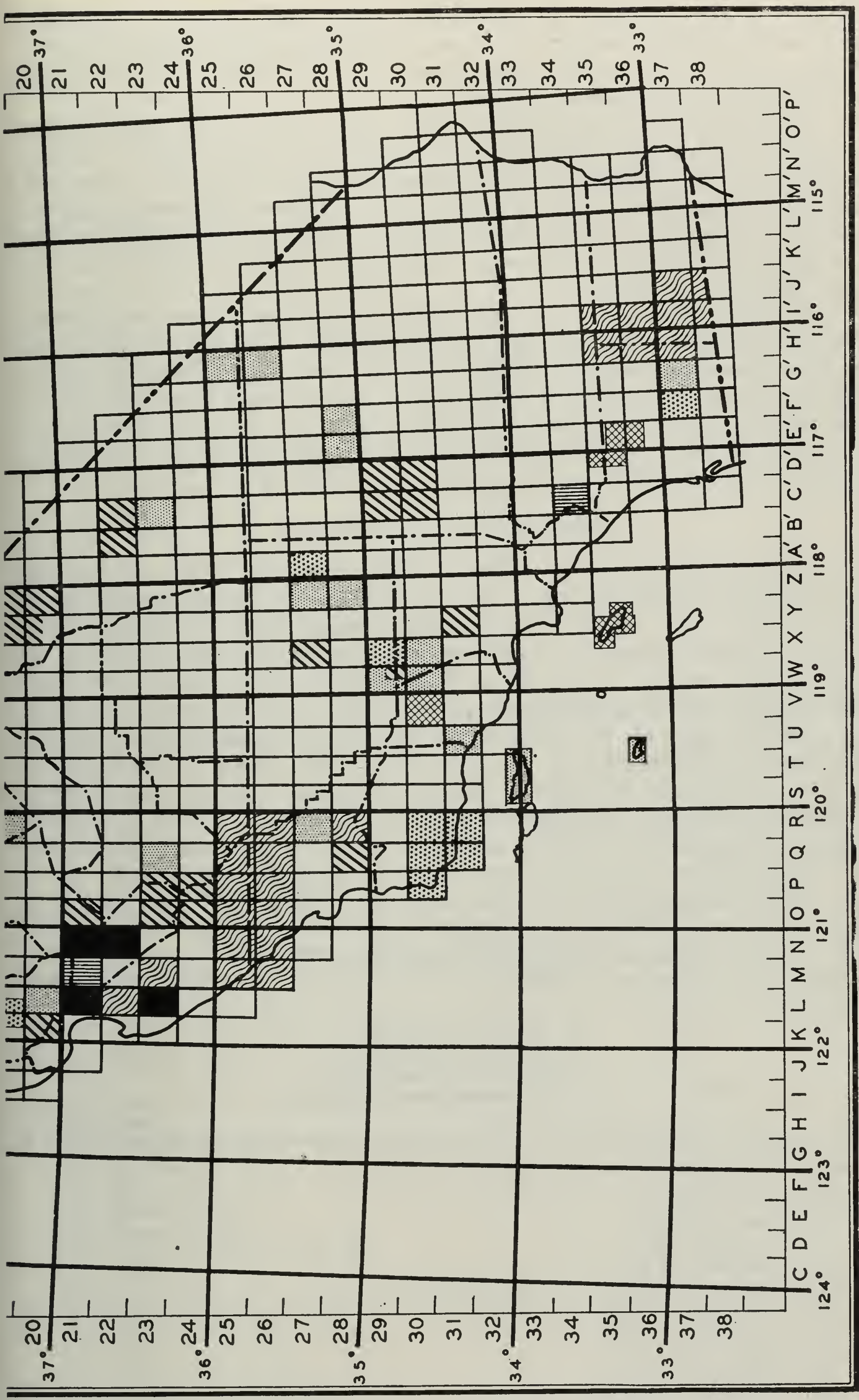
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FIGURE 3. Map of California; Index to quadrangles.

three on *Water-Flooding as a Method of Increasing California Oil Production.* In addition, reports of current activities in the monthly *Mineral Information Service* and three new county reports contained information of interest to the petroleum industry.

During the year progress was made in this office on (1) a map of the state showing locations of oil fields and dry holes drilled outside the fields on a background geologic map, (2) a revised list of dry holes, including geologic information, (3) a supplement to Bulletin 118, which will include several papers on fields currently active, and (4) processing reports for publication on the Bitterwater Creek area of Kern County, and the type Moreno formation.

Information on other raw materials as possible sources of mineral fuel—bituminous sand and shale, coal and peat—was accumulated and used in answering inquiries from the U. S. Army Engineers, industrial consultants, and the general public. Short reports were published on the manufacture of montan wax in Amador County, the only present usage of California coal. As its resources allow, the Division plans to extend and expand its studies of bituminous sand, coal, and peat.

BASIC GEOLOGIC MAPPING

The Division's program of basic geologic mapping of the state on the scale of approximately a mile to the inch was accelerated during the fiscal year 1949-50. The colored lithographed geologic maps published continued in great demand by petroleum and mining companies carrying on exploration programs, as well as by engineers, agriculturists, and the scientifically interested public. Eventual objective is coverage of the state by geologic maps on the 15-minute topographic quadrangles issued by the United States Geological Survey. Some of the geologic field mapping is done directly by Division of Mines' geologists, some by the Federal Geological Survey in cooperation with the Division, and some by professional geologists with various affiliations; the largest contribution has come through the geological departments of the large universities.

The following list shows progress of the basic geologic mapping program to July 1, 1950. The quadrangles listed are 15-minute (scale 1:62,500), unless otherwise indicated. The letter preceding the name of the quadrangle indicates the affiliation of the geologists who are doing the work:

D—Division of Mines
U—University geologist
S—Federal Geological Survey
O—other professional geologist

The symbol (example, H 15) following the quadrangle name serves as a means of locating it on the index map (fig. 3.)

Published, with report:

(U) Antioch (K 16)
(U) Blue Lake (C 5)
(U) Carquinez (J 16)
(U) Jamesburg (L 23)
(U) Macdoel, 30-min. (I 1, I 2, J 1, J 2)
(U) Mare Island (I 16)
(U) Mount Vaca (J 15)
(U) Petaluma (H 16)
(U) Point Reyes (G 16)

(U) Quien Sabe (N 21)
(U) San Benito (N 22)
(U) San Juan Bautista (L 21)
(U) Santa Rosa (H 15)
(U) Sonoma (I 15)
(U) Tesla (L 18)
(U) Vacaville (K 15)

Geologic maps published; reports in preparation:

(U) Copperopolis (P 17)
(U) Hollister (M 21)
(O) Lake Elsinore (C′ 34)

Geologic maps and reports in press:

(U) Blue Lake (C 5)
(S) Cuyamaca Peak (F′ 37)
(O) Gaviota (R 31)
(U) Healdsburg (G 14)
(O) Lompoc (Q 30)
(O) Los Olivos (R 30)
(S) Neenach (X 29)
(O) Point Arguello (P 30)
(O) Point Conception (Q 31)
(O) Saltdale (A′ 27)
(U) San Jose (E ½)–Mt. Hamilton (W ½) (KL 19)

Geologic maps and reports nearly ready for press:

(S) Gasquet (C 1)
(O) Hines Peak (V 30)
(S) Mother Lode (P 16, Q 17)
(S) Pala pegmatite area (D′ 35, E′ 35, E′ 36)
(S) Santa Catalina Island (X 35, Y 35)

Geologic mapping practically completed; reports in preparation:

(D) Barstow, 30-min. (C′ 29, C′ 30, D′ 29, D ′30)
(S) Big Pine (Y 20)
(S) Bishop (Y 19)
(O) Breckenridge Mt. (X 27)
(S) Cerro Gordo (B′ 22)
(U) Lebec, 7½-min. (W 29)
(S) Mt. Goddard (X 20)
(S) Mt. Humphreys (X 19)
(S) New Almaden (K 20)
(U) Nipomo (Q 28)
(U) Ortigalita Peak (O 21)
(U) Priest Valley, 30-min. (O 23, O 24, P 23, P 24)
(U) St. Helena (I 14)
(D) San Fernando (Y 31)
(S) Shasta Copper Belt (I 5,6)
(S) Ubehebe (C′ 22)

Geologic maps in preparation; field work completed or nearly completed; reports to be written:

(U) Adelaida (O 26)
(U) Bradley (O 25)
(U) Branch Mt. (R 28)
(U) Bryson (N 25)
(U) Capay (J 14)
(U) Cape San Martin (M 25)
(U) Carbona (M 18)
(U) Cholame, 30-min. (Q 25, Q 26, R 25, R 26)
(U) Dardanelles Cone (S 15)
(U) Desert Creek Peak (U 14)
(U) Ebbett Pass (S 14)
(O) Imperial Valley quadrangles
    Agua Dulce (H′ 35)
    Barrel Spring (H′ 36)

- Brawley (J′ 37)
- Carrizo Mt. (H′ 37)
- Coyote Wells (H′ 38)
- Durmid (I′ 35)
- Heber (J′ 38)
- Kane Spring (I′ 36)
- Plaster City (I′ 37)

(U) Lodoga (I 11)
(D) Masonic Mt. (V 15)
(U) Paso Robles (P 26)
(U) Piedras Blancas (M 26)
(U) Reiff (I 13)
(U) Rumsey (J 13)
(U) Salinas (L 22)
(U) San Miguel (P 25)
(U) San Simeon (N 26)
(U) Sebastopol (G 15)
(U) Skagg (F 14)
(U) Soledad (M 23)
(U) Sonora Pass (T 15)
(U) Sutter Creek (O 15)
(U) Topaz Lake (T 14)
(U) Wheeler Peak (U 15)
(U) Wilbur Springs (I 12)

Geologic mapping underway; reports to be prepared:

(U) Alvord Mt. (F′ 28)
(U) Big Bend Mt. (M 10)
(U) Blairsden (P 9)
(U) Cross Mt. (Z 27)
(U) Cuyapaipe (G′ 37)
(S) Darwin (C′ 23)
(U) Ferndale (A 6)
(U) Fortuna (B 6)
(U) Indian Gulch (R 19)
(U) Joaquin Rocks (Q 23)
(U) Lane Mt. (E′ 28)
(U) La Panza (R 27)
(D) Matterhorn Peak (U 16)
(U) Mojave (Z 27)
(U) Morgan Hill (L 20)
(S) Mother Lode (N 15, O 15, P 16)
(S) New Almaden (K 20)
(U) Oroville (L 10)
(U) San Nicolas Island (T 35)
(O) Santa Cruz Island (S 32)
(S) Shasta Copper belt (H 6, I 6, J 6)
(U) Silurian Hills (H′ 26)
(D) Tecopa (H′ 25)

REGIONAL STATE MAP

The colored regional geologic map of the state, scale 1 : 500,000, issued by the Division in 1938, has been one of the most widely used of all contributions to the geology of California. It represents the best available information for the state as a whole. Eventually it should be completely revised and reissued. Data for this revision are now being compiled.

The geologic map of the state is also printed without color on the scale, 1 : 1,000,000 and has been used as the base for showing the distribution of mineral commodities. This map, with the mineral commodity shown in red, has been issued for oil and gas, quicksilver, chromite, manganese, tungsten, and copper.

MINING AND GEOLOGIC GUIDEBOOKS

Because the general public has difficulty in understanding works on mining and geological subjects as ordinarily phrased in the language of the profession, the Division of Mines has inaugurated a series of bulletins written in language more readily grasped by the layman. Bulletin 141, *Geologic Guidebook Along Highway 49—Sierran Gold Belt, The Mother Lode County,* the first of these works, was so enthusiastically received that two printings, each many times as large as required for most Division of Mines technical publications have been necessary.

In response to the reception accorded Bulletin 141 and at the request of individuals and organizations in the San Francisco Bay area, the Division of Mines has in preparation a guidebook designed to cover the 12 counties bordering on the Bay system. It is designed not only to satisfy demand in the Bay region but to serve as background for an industrial study now being made by the San Francisco Chamber of Commerce. *The San Francisco Bay Counties Geologic Guidebook,* as it will be called, will consist of contributions from more than 25 eminent scientists, and will be profusely illustrated by photographs, diagrams, cross sections, and maps. Complete geologic guides to the main routes of travel are being prepared as well as miscellaneous notes on points of interest to be found along routes less well travelled; a general geologic map will accompany the notes. The location and use of all mineral deposits adjacent to the Bay as well as minerals brought in from outside are discussed.

Manuscript of another general book on the elements of geology is now being processed. There long has been the need and request for this sort of fundamental information. This book will discuss the surface features and physiographic development of the landscape of California, readable in grade and preparatory schools as well as in technical or semi-technical circles. *The Evolution of California's Landscape,* a product of the Division of Mines' cooperative program with the University of California, is a comprehensive work predominantly of pictorial nature supported by a simplified text, diagrams, and captions.

These publications serve to educate the public on the importance of California's versatile minerals industry and its relation to the rapidly increasing population of the Pacific Coast.

CONTINUED GROWTH OF THE LOS ANGELES BRANCH

The continued growth of population and industry in the Los Angeles area has reflected upon the Division of Mines branch located in this district increasing its public services work load. At least 8 percent more office work was done than in the 1948-1949 fiscal year, which was the peak year of any time previous. To meet this growing condition, the Division of Mines has found it necessary to send much needed technical employees from the San Francisco office to assist in the work in the Los Angeles office and in the field of southern California.

The local library in this office has been expanded, the mineral collection has been improved, and physical changes have been made in the office to meet the crowded condition.

The work of the Los Angeles office is so closely coordinated with that of the headquarters office in San Francisco that for the purposes of this annual report the activities of the two offices have been reported together.

In order to carry on the Division's plan for the mineral utilization survey in the industrial district, and in order to coordinate this with studies of potential mineral resources in the region, it will be imperative that the staff of the Los Angeles branch be considerably increased. The mineral resources of San Bernardino County are particularly extensive and the study of this region must be continued as it has recently been done in Inyo County. The field of activities throughout the whole region is very large indeed and its importance is seldom realized.

To administer the technical investigations of mineral resources throughout the state, it is found that two strong offices, one at the headquarters in San Francisco and one in Los Angeles, can more effectively serve the public and supervise the field work than if the Division maintains various smaller field offices in various parts of the state. For this reason, the Division recommends that the public seeking technical information should endeavor to contact either the headquarters office in San Francisco or the branch in Los Angeles.

REPORT OF THE U. S. GEOLOGICAL SURVEY ON COOPERATIVE PROGRAM

(Annual Report, July 1949-June 1950 Fiscal Year)
(Submitted by United States Geological Survey)

During fiscal 1950 the expenditures by the U. S. Geological Survey for geological investigations of mineralized areas in California, under its cooperative agreement with the California State Division of Mines, were increased moderately. Expenditures for the year amounted to $124,369 compared with about $97,000 the previous year. Of the total, the state paid $50,000 and the Survey the remaining $74,369. Additional federal allotments amounting to $5,030 also supported the preparation of reports on the quicksilver deposits of California.

The Survey personnel assigned to the program included 10 full-time and 16 part-time employees. The part-time employees included one clerk-stenographer on the office force at San Francisco; the other part-time employees were geologists on temporary assignments. The total time on the program was equivalent to about 15 man-years.

Five major field projects were in progress during fiscal 1950. These, together with an account of the activities of the San Francisco office, are briefly reviewed below.

Shasta Copper Belt. Work during fiscal 1950 was still concentrated in the main, western zone of mineralization of the Shasta copper belt, where geologic investigations already were well advanced; but an eastward extension of the mapping was started. Notable developments in the west Shasta area included the following: (1) General mapping of the geology on a scale of 1: 24,000 was completed in the Kennett quadrangle and was extended northward from the Mammoth mine in the northern part of the Backbone quadrangle. (2) Detailed mapping of the surface and underground geology of the Shasta King mine was completed. (3) Reports were prepared on the Iron Mountain and Shasta King mines. (4) Of especial interest—diamond drilling near Iron Mountain was started. The drilling, done by the Geological Survey under an allotment of federal funds, is to obtain additional geologic data in an area where geologic mapping had discovered rocks and structures similar to those that contain ore bodies at Iron Mountain. The drilling was still under way at the year end.

The first work in the east Shasta area was detailed mapping of the surface and underground geology at the Afterthought mine. This study was continued as general mapping of the surrounding area at a scale of 1:24,000.

During the coming fiscal year, work will continue in both the east and the west Shasta districts in about equal amounts.

Mother Lode Gold Belt. Mapping of the general geoloy of the Mother Lode belt, on a scale of 1:24,000 was continued in fiscal 1950. Field work consisted partly of checking the geology in critical areas in the San Andreas SE and Sonora quadrangles, but a major part of the year was devoted to preparing and revising a report on this area. In addition, field work was started to extend the geologic mapping northward.

Bishop Tungsten District. The purpose of the investigations in the Bishop region is to make a comprehensive study of the geology, with special emphasis on the economic geology of the tungsten deposits. This area comprises about 1,000 square miles, and includes most of four 15-minute quadrangles: the Bishop, Big Pine, Mt. Humphreys, and Mt. Goddard quadrangles. Field work during fiscal 1950 consisted mainly in mapping the general geology in the Big Pine quadrangle, but in addition major new developments in the Pine Creek tungsten mine also were examined. Laboratory work consisted of examining ore and rock specimens and in compiling the geologic maps of the quadrangles.

A new technique in the map compilation was tried with notable success. Through the cooperation of the Topographic Division of the U. S. Geological Survey, the field maps showing the geology on air photographs were processed in the topographic laboratory at Sacramento, and the geologic data were transferred by multiplex to the new topographic sheets. This provided a first draft of the geologic compilation with a precision equal to that obtained in the togographic contouring by multiplex, and at a cost substantially less than if the geologist had made the compilation by other methods.

Final field mapping on the project is scheduled for the summer of 1950, and the remainder of the fiscal year will be devoted to laboratory work and preparation of the final comprehensive report.

Cerro Gordo-Ubehebe Lead-Zinc District. Two parties worked in the lead-zinc investigations in Inyo County, one in the Cerro Gordo (New York Butte) quadrangle and the other in the adjoining Ubehebe Peak 15-minute quadrangle. The Cerro Gordo work consisted in mapping the general geology in the northern and eastern parts of the quadrangle, and studying in detail four small mineralized areas. At Ubehebe Peak activities centered around field work, but considerable office and laboratory work in the field office also was done. Field mapping of the general geology on air photographs was completed by the end of the year; compilation on the new topographic sheet and final field checking remain to be done. A report on the rocks and structure of the critical adjoining Quartz Spring area was prepared and is being processed for release. This report describes the stratigraphy of the Paleozoic rocks of the area, and it will serve as a basic reference for future work on the Paleozoic strata in the region around Ubehebe Peak.

California Chromite. Field investigations of chromite deposits in fiscal 1950 were limited to two weeks' work, which consisted of a restudy of a critical area in El Dorado County. The remainder of the year was devoted to preparing reports for publication as chapters of Bulletin 134 of the State Division of Mines. This report-writing is scheduled for completion in fiscal 1951. Of four chapters remaining to be finished, three are scheduled for transmittal to the state during fiscal 1951, and the final chapter the following year.

San Francisco Office. Through fiscal 1950 the staff at the headquarters of the cooperative program in San Francisco included two clerk-stenographers, a draftsman, and a scientific aide. The principal task was in assisting with texts and illustrations of geologic manuscripts, but the staff handled correspondence and supplies as well. During the fiscal year, 21 reports containing a total of 2,225 manuscript pages and 623 illustrations were processed. Twelve reports were transmitted to the Division of Mines for publication. Of the total material, 76 percent was the direct result of the cooperative program.

CONCLUSIONS

The Division of Mines acts as an information bureau on California's mineral resources, mineral industries, mining operations, basic geology, and related subjects. To give authentic information, it must maintain a staff of technical persons trained in the professions of mineralogy, geology, mining engineering, and related subjects, who must make surveys and investigations of mineral deposits in the state and the raw mineral materials used in various industries, and should do research work in the laboratory and library on their subjects. This staff must be acquainted with the work of technical persons of other similar agencies. The Division should cooperate, so far as possible, with other governmental agencies and educational institutions in order to acquire as much authoritative information as possible.

To inform the public and thereby assist in developing the state's bountiful supply of mineral resources, is the principal objective of the Division of Mines. This is done orally and by letter but most effectively and permanently through its publications.

To acquire information, to prepare reports concerning it, to process these reports for publication, and finally to issue authoritative public documents and distribute them for use throughout the state, the nation, or anywhere else when information is desired, requires continuous diligence and unselfish interest on the part of each and every employee. The public documents are placed on the shelves of libraries where they will remain for years and, therefore, the information printed in them must be authoritative and useful for all time to come.

Compensation for this work consists for the most part in the satisfaction given to the people of California and to other investors in the state's resources and industries. This satisfaction has made itself manifest in many letters and comments which have been received during the past fiscal year. It will only be through expressions of continuous interest of the public who have been rendered satisfactory services that the Division of Mines will be able to maintain a useful organization, to carry on needed activities, and to contribute to the economic welfare of the state.

COUNTIES OF CALIFORNIA—MINERAL PRODUCTION AND SIGNIFICANT MINING ACTIVITIES OF 1949

PREPARED UNDER THE DIRECTION OF CHARLES V. AVERILL AND L. A. NORMAN, JR.*

OUTLINE OF REPORT

Page

INTRODUCTION ---- 272

MINERAL PRODUCTION IN CALIFORNIA DURING 1949 COMPARED WITH 1948 ---- 273

DETAILS OF MINERAL PRODUCTION FOR EACH COUNTY, 1948 AND 1949 ---- 289

COUNTY SUMMARIES ---- 309

- Alameda County ---- 309
- Alpine County ---- 310
- Amador County ---- 310
- Butte County ---- 313
- Calaveras County ---- 314
- Colusa County ---- 317
- Contra Costa County ---- 317
- Del Norte County ---- 319
- El Dorado County ---- 319
- Fresno County ---- 321
- Glenn County ---- 323
- Humboldt County ---- 323
- Imperial County ---- 325
- Inyo County ---- 326
- Kern County ---- 329
- Kings County ---- 331
- Lake County ---- 331
- Lassen County ---- 332
- Los Angeles County ---- 333
- Madera County ---- 335
- Marin County ---- 336
- Mariposa County ---- 337
- Mendocino County ---- 339
- Merced County ---- 339
- Modoc County ---- 340
- Mono County ---- 342
- Monterey County ---- 343
- Napa County ---- 345
- Nevada County ---- 346
- Orange County ---- 347
- Placer County ---- 349
- Plumas County ---- 350
- Riverside County ---- 351
- Sacramento County ---- 353
- San Benito County ---- 354
- San Bernardino County ---- 355
- San Diego County ---- 359
- San Francisco County ---- 361
- San Joaquin County ---- 361
- San Luis Obispo County ---- 363
- San Mateo County ---- 364
- Santa Barbara County ---- 365
- Santa Clara County ---- 367
- Santa Cruz County ---- 368
- Shasta County ---- 369
- Sierra County ---- 371
- Siskiyou County ---- 373
- Solano County ---- 376
- Sonoma County ---- 377
- Stanislaus County ---- 378

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OUTLINE OF REPORT—Continued

Page
Sutter County ---- 380
Tehama County ---- 380
Trinity County ---- 381
Tulare County ---- 383
Tuolumne County ---- 384
Ventura County ---- 385
Yolo County ---- 387
Yuba County ---- 388

DIRECTORY OF PRODUCERS OF METALLIC AND NONMETALLIC MINERALS IN CALIFORNIA DURING 1949 ---- 391
Nonmetallics ---- 393
Metallics ---- 434

DIRECTORY OF MINERAL DEALERS AND COMMERCIAL LABORATORIES ---- 453
List of mineral dealers, custom mills, and commercial grinding plants in California ---- 455
List of smelters and mineral dealers reporting purchase of California metals produced in 1949 ---- 458
List of commercial assay and testing laboratories ---- 460

Illustrations

Plate 19. *A*. Quarry and crushing plant, American Perlite Company, Fish Springs, Inyo County. *B*, Quarry, Redlite Cinder Company, Inyo County ---- 336-337
20. Johns-Manville Celite plant, Lompoc, Santa Barbara County ---- 336-337
21. Plant and quarry, Rocklite Products, Ventura ---- 336-337
22. Monolith Portland Cement Company plant, Monolith, Kern County 336-337
23. Johns-Manville Celite plant, Lompoc, Santa Barbara County ---- 336-337
24. *A*, Bucket-line dredge, Yuba Consolidated Gold Fields, Butte County. *B*, Hydraulic mining at the Rex mine near Weaverville, Trinity County ---- 336-337
25. *A*, Basalite plant, Basalt Rock Company, Stockton, San Joaquin County. *B*, Loading a kiln, Sacramento Brick Company, Sacramento County ---- 336-337
26. *A*, Mill, Sarita Milling Company, Chemung mine, Mono County. *B*, Sarita mine, near Masonic, Mono County ---- 336-337
27. *A*, Gypsum quarry, Monolith Portland Cement Company, Quatal Canyon, Ventura County. *B*, Processing plant, Insulating Aggregate Company, Mono County ---- 336-337
28. *A*, Kaolin deposit, Huntley Industrial Minerals, Inc., Mono County. *B*, Fouch pit, Glass Mountain, Siskiyou County ---- 336-337
29. *A*, Quarry and screening plant, Structurelite Company, Modoc County. *B*, Loading black pumice at quarry, U. S. Pumice Supply Company, Mono County ---- 336-337
30. *A*, Eagle Mountain iron deposit, Kaiser Company, Inc., Riverside County. *B*, Eagle Mountain iron deposit, Kaiser Company, Inc., Riverside County ---- 336-337

INTRODUCTION

Presentation of mineral statistics in 1947[1] and 1948[2] differed from previous releases in that in the former (1947) the mineral resources of California were described with emphasis on the counties, and in the latter (1948) with emphasis on the mineral commodities. The present report describes the mineral production of California's 58 counties during 1949, and summarizes significant mineral industry activities of each county: it is thus a supplement to Bulletin 142, *The Counties of California.*

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[1] Jenkins, Olaf P., The counties of California, mineral resources and mineral production during 1947: California Div. Mines Bull. 142, 1949.

[2] Jenkins, Olaf P., Mineral commodities of California, geologic occurrence, economic development, and utilization of the state's mineral resources: California Div. Mines Bull. 156, 1950.

Data presented herein have been compiled by the United States Bureau of Mines in cooperation with the State Division of Mines. Several staff members of the Division of Mines have contributed to the text. The author's initials follow each county summary. Contributing authors are: Charles V. Averill, James W. Crosby III, Fenelon F. Davis, George C. Hazenbush, L. A. Norman Jr., John C. O'Brien, Salem J. Rice, Richard M. Stewart, Henry H. Symons, Mort D. Turner, James W. Vernon, and Lauren A. Wright.

Contribution of the Counties to the Mineral Production of California During 1949. Eight of the 10 leading counties in value of mineral production during 1949 were petroleum or natural gas producers. Los Angeles County moved into first place for the first time since 1943. Kern County, which held first place for the 5 preceding years, dropped to second position owing largely to a $50,000,000 reduction in the value of petroleum produced. Fresno County, another petroleum producer, retained third position; but Ventura County moved into fourth place ahead of Orange County. Incidentally, Ventura County was the only leading petroleum producer to register an increase in the quantity and value of petroleum production during 1949. This increase was the result of extension of production limits at the Ventura, Rincon, and South Mountain oil fields. Sixth position was occupied by Santa Barbara County, which was followed by the counties of San Bernardino, Kings, Sacramento, Santa Clara, Riverside, Alameda, Solano, San Luis Obispo, and Inyo. San Luis Obispo County attained fourteenth place on the list of 58 counties compared to twenty-eighth place in 1948. This is the highest position ever held in the list by San Luis Obispo County, and was the result of rapid development of Cuyama Valley oil fields. Nevada County, the leading gold producer (chiefly from lode mines) ranked nineteenth.

San Bernardino County produced 27 different mineral substances in 1949 and was the leading county in diversity of mineral production; followed by Inyo with 17 mineral substances; Los Angeles with 14; Kern with 13; Fresno with 12; and Monterey, Riverside, and Shasta with 10 each.

Mineral productions with total value exceeding a million dollars were reported in 31 counties during 1949. Million-dollar production values were reported from one or more counties during 1949 for each of the following 19 mineral products: boron minerals, cement, diatomite, gold, gypsum, iron ore, lead, natural gas, natural-gas gasoline, liquefied petroleum gases, petroleum, potassium salts, salt, sand and gravel, sodium salts, stone, talc, tungsten, and zinc.

MINERAL PRODUCTION IN CALIFORNIA DURING 1949 COMPARED WITH 1948

By Henry H. Symons, Fenelon F. Davis, and L. A. Norman Jr.

The total value of the mineral output in California during 1949 exceeded the billion dollar mark for the second consecutive year, although it fell short of the all-time high reached in 1948. The total value of the California mineral output for 1949 was $1,074,416,000, compared with

QUANTITY AND VALUE OF MINERAL SUBSTANCES PRODUCED IN CALIFORNIA DURING 1947, 1948, AND 1949

The following figures for the three years 1947, 1948, and 1949, are supplied by the United States Bureau of Mines, with which the California State Division of Mines has a cooperative agreement for the collection of these statistics, starting with the year 1947.

Minerals	1947		1948		1949	
	Short tons (unless otherwise stated)	Value in Dollars	Short tons (unless otherwise stated)	Value in Dollars	Short tons (unless otherwise stated)	Value in Dollars
Antimony ore and concentrates.....gross weight..	------------	------------	5	1,467	------------	------------
Boron minerals..................................	501,935	11,844,108	450,932	11,147,735	467,592	11,511,893
Calcium-magnesium chloride						
75% (Ca, Mg)Cl_2 basis..	7,968	111,950	10,009	167,610	11,166	204,024
Cement...............(barrels, 376 pounds net)..	22,846,458	46,539,749	24,162,926	57,742,226	23,201,982	57,464,213
Chromite........................gross weight..	948	(1)	274	(1)	433	11,662
Clays (except for cement).........................	*1,493,570	*2,725,282	*1,758,256	*3,252,017	1,391,088	2,744,069
Fuller's earth................................	(1)	(1)	(1)	(1)		
Coal: Lignite......................................	------------	------------	1,450	14,500	3,900	39,000
Copper..........................Cu content..	2,407	1,010,940	481	208,754	649	255,706
Gold..................troy ounces, Au content..	431,415	15,099,525	421,473	14,751,555	417,231	14,603,085
Gypsum (crude)..................................	811,798	1,996,157	962,038	2,354,390	753,581	1,852,452
Iron ore (usable).........long tons, gross weight..	373,574	(1)	345,863	(1)	584,109	(1)
Lead..............................Pb content..	10,080	2,903,040	9,110	3,261,380	10,318	3,260,488
Lime (open-market)................................	181,296	2,615,599	179,257	3,026,941	153,483	2,516,262
Magnesium compounds from sea water and bitterns (partly estimated)............MgO equivalent..	40,000	2,161,000	38,500	2,549,000	27,600	1,770,000
Manganese ore (35% or more Mn) ..gross weight..	------------	------------	------------	------------	280	(1)
Manganiferous ore (5 to 35% Mn).........do....	------------	------------	------------	------------	386	(1)
Mercury........(flasks, 76 pounds, Hg content)..	17,165	1,437,397	11,188	855,770	4,493	357,014
Natural gas................thousand cubic feet..	560,510,000	57,284,000	570,954,000	64,803,000	539,550,000	65,825,000
Natural-gas liquids:						
Natural gasoline and cycle products....gallons..	833,473,000	46,302,000	*844,961,000	*62,834,000	[2]862,143,000	[2]65,827,000
Liquefied petroleum gases..............do....	230,635,000	7,901,000	*270,103,000	*16,527,000	[2]275,318,000	[2]19,080,000

Peat	3,431	22,209	6,942	33,265	5,670	35,193
Petroleum (crude) (barrels, 42 gallons)	333,132,000	572,990,000	*340,074,000	*822,980,000	[2]332,839,000	[2]752,220,000
Platinum group (crude) troy ounces, metals content	324	(1)	272	(1)	(1)	(1)
Pumice and pumicite	169,037	1,026,275	196,934	1,110,447	149,878	799,602
Salt (common)	768,397	3,810,898	914,035	3,927,722	964,807	4,110,271
Sand and gravel	31,386,826	25,338,967	33,786,520	30,592,965	36,279,816	30,198,924
Silver troy ounces, Ag content	1,597,442	1,445,685	724,771	655,954	783,880	709,451
Sodium carbonate (natural)	293,051	5,862,178	288,769	6,623,280	200,496	4,163,714
Stone[3]	[3]12,757,790	[3]13,012,556	[3]11,936,240	[3]13,155,454	11,373,700	12,594,048
Sulfur ore for direct agricultural use long tons	698	9,074	(1)	(1)	1,302	26,444
Talc, pyrophyllite, and ground soapstone	91,537	1,595,422	98,681	1,773,764	83,359	1,434,046
Tungsten concentrates 60% WO_3 basis	394	548,233	1,767	(1)	952	(1)
Zinc Zn content	5,415	1,310,430	5,325	1,416,450	7,209	1,787,832
Other minerals: Abrasive stone (pebbles for grinding), asbestos, native asphalt (1947), barite, bromine, carbon dioxide (natural), diatomite, feldspar, gem stones, iodine, lithium minerals, magnesite, mica, molybdenum concentrates, perlite (1948-49), potassium salts, pyrites, quartz, ground sand and sandstone, sodium sulfate, slate, stone (marble 1947, dimension basalt 1948), titanium concentrates (1948-49), and minerals indicated by footnote 1	----------	*16,509,285	----------	*20,644,200	----------	19,015,094
Total California (rounded)	----------	*843,413,000	----------	*1,146,411,000	----------	1,074,416,000
Clay sold or used for cement	456,506	240,078	915,621	561,312	838,631	503,968
Coke	332,244	(4)	296,749	(4)	346,552	(4)
Ferro-alloys	5,278	(4)	(4)	(4)	(4)	(4)
Iron, pig	453,376	(4)	375,113	(4)	494,300	(4)

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[1] Value included with "Other minerals."
[2] Preliminary figure.
[3] Except limestone for cement and lime and certain stone in 1947-48 included with "Other minerals."
[4] Bureau of Mines not at liberty to publish figure.
* Revised figures.

the 1948 total value of $1,146,411,000 (revised), as compiled by the U. S. Bureau of Mines. The decrease of $71,995,000 in the value of the state's 1949 mineral output was chiefly the result of a small decrease in the quantity of petroleum produced and lower prices paid for crude oil. Boron minerals, natural gas, natural-gas gasoline, liquefied petroleum gases, salt, and zinc registered substantial increases in value of production during 1949. The quantity and value of natural-gas gasoline, liquefied petroleum products, and salt produced in 1949 were the highest on record. The value of natural gas produced in 1949 was also the highest on record, although the quantity produced was slightly under the 1948 production figure. All 58 counties of the state contributed to the production of 52 commercial mineral substances.

Abrasive Stone (Pebbles for Grinding). Pebbles for grinding, produced in small quantities in California since 1915, have been harvested largely from the beaches of San Diego County. In recent years, the output has been utilized principally as filter media. The 1949 output was reported from Encinitas Beach, San Diego County.

Antimony. No shipments of antimony ore were reported from California mines during 1949. In 1948 the Rocket mine in Inyo County shipped 5 tons of antimony ore worth $1,467.

In 1949 some development work was done on antimony properties in San Benito and Kern Counties.

Asbestos. The asbestos produced in California and shipped during 1949 came from a single property in Shasta County and was the tremolite variety. Development work in the state was carried on during the year at single tremolite properties in Inyo and Shasta Counties, and at a chrysotile property in Shasta County.

Asphalt, Native (Bituminous Rock). No shipments of bituminous rock were reported in 1948 or 1949 from California deposits. Annual production had been reported continuously for the period 1887-1947 inclusive. The rock quarried in 1947 came from a large deposit in Santa Cruz County, which had been the principal producer for many years. The plant was dismantled in 1948.

Barite. Barite shipped in California during 1949 came from single properties in Mariposa and Plumas Counties. The 1948 output was from one property in Mariposa County.

Boron Minerals. Shipments of borates from California deposits during 1949 totaled 467,592 short tons containing 139,200 tons of B_2O_3 worth $11,511,893, compared with 450,932 short tons containing 134,700 tons of B_2O_3 worth $11,147,735 during 1948. The 1949 output came from properties operated by two companies in Inyo County, two companies in San Bernardino County, and by a single company in Kern County.

Bromine. Bromine produced in California during 1949 was recovered from sea-water bitterns obtained from the salt plants in Alameda County on San Francisco Bay, and from the brines of Searles Lake in San Bernardino County.

Calcium Chloride. The calcium chloride produced in California during 1949 totaled 11,166 short tons of 75 percent $(Ca,Mg)Cl_2$ material valued at $204,024, as compared with 10,009 short tons of 75 percent $(Ca,Mg)Cl_2$ worth $167,610 in 1948. All the material came from properties on Bristol Lake near Amboy, San Bernardino County.

Carbon Dioxide (Natural). Carbon dioxide was produced in California during 1949 from wells near Niland, Imperial County, and from wells near Hopland and Ukiah in Mendocino County. The carbon-dioxide gas from Imperial County in 1949 totaled 135,260 thousand cubic feet [1] compared with 150,780 thousand cubic feet [1] in 1948. Most of this natural carbon dioxide was used in the manufacture of dry ice.

Cement. The cement output in California during 1949 came from three mills in San Bernardino County, and one mill in each of the following counties: Calaveras, Kern, Los Angeles, Riverside, San Benito, San Mateo, Santa Clara, and Santa Cruz. Production totaled 23,218,356 barrels compared with 24,601,892 barrels in 1948.

In 1949 shipments from the 11 California mills totaled 23,201,982 barrels worth $57,464,213, compared with 24,162,926 barrels worth $57,742,226 in 1948. The estimated capacity of the state's cement mills for 1949 was 29,870,000 barrels, compared with 29,170,000 barrels for 1948.

Chromite. The chromite shipped from California during 1949 totaled 433 short tons valued at $11,662, and came from two properties in Del Norte County, and from single properties in Butte and Tehama Counties. The 1948 chromite shipments totaled 274 short tons and came from single properties in Butte and Del Norte Counties.

Clay. The clay used and sold in California during 1949 totaled 2,229,719 short tons worth $3,248,037; of which 838,631 short tons worth $503,968 were used in the manufacture of cement, and 1,391,088 short tons worth $2,744,069 consisted of ceramic clay, oil-well drilling mud, bentonite, and other miscellaneous clays.

In 1948, clay output totaled 2,673,877 (revised) short tons worth $3,813,329 (revised); of which 915,621 short tons worth $561,312 were used for cement, and 1,758,256 short tons worth $3,252,017 were utilized for other purposes.

The figures for clay used in the manufacture of cement are not included in the tabulated totals of state mineral production as separate data are provided.

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[1] Figures from California State Division of Oil and Gas.

Clay sold and used in California during 1949, by counties.

County	Short tons	Value
Alameda	17,837	$21,017
Amador	84,286	160,061
Kern[2]	202,509	699,635
Los Angeles	402,853	299,810
Orange	20,835	87,932
Riverside[2]	293,765	585,657
Sacramento	28,452	[1]
San Bernardino[2]	139,376	414,530
San Joaquin	19,803	15,557
Santa Clara[2]	200,024	[1]
Calaveras[2], Contra Costa, Fresno, Humboldt, Inyo, Marin, Placer, San Benito[2], San Mateo[2], Santa Barbara, Santa Cruz[2], Stanislaus, Sutter, Tulare, Ventura, Yolo[1]	819,979	963,838
Totals	2,229,719	$3,248,037

[1] Figures combined to avoid disclosure of individual output.
[2] Includes clay used in cement.

In 1949 California produced 363,492 short tons of fire clay worth $788,674, and a total of 18,847 short tons of kaolin, or china clay, worth $402,745.

Coal. During 1949 a total of 3,900 short tons of lignite worth $39,000 was produced from a mine near Ione, Amador County, compared with the 1948 output of 1,450 short tons worth $14,500. The lignite was sent to a plant for the extraction of montan wax. This is a hard wax that can be substituted for carnauba in the manufacture of such products as shoe polish and carbon paper.

Copper. The mine production of recoverable copper in California during 1949 totaled 1,298,000 pounds worth $255,706, as compared with 962,000 pounds valued at $208,754 in 1948.

Most of the copper produced during the year was from the zinc-copper ores of Calaveras, San Bernardino, and Shasta Counties; and as a by-product of tungsten ores from Inyo County.

Diatomite. The diatomite shipped in California during 1949, came from single properties in Inyo, Los Angeles, Santa Barbara, Siskiyou, and Sonoma Counties.

California leads the states of the nation in the production of diatomite.

Mine production of recoverable copper in California during 1949, by counties.

County	Pounds	Value	County	Pounds	Value
Amador	300	$59	Riverside	5,100	$1,005
Calaveras	76,500	15,070	San Bernardino	135,500	26,694
Inyo	421,300	82,996	Shasta	653,900	128,818
Mariposa	200	39	Siskiyou	1,600	315
Mono and Monterey[1]	100	20			
Plumas	3,500	690	Total	1,298,000	$255,706

[1] Combined to avoid disclosure of individual output.

Feldspar. Feldspar shipped in California during 1949, came from properties in Inyo, Madera, and San Bernardino Counties; that shipped in 1948, was from properties in Kern and San Bernardino Counties.

Gem Stones. A large variety of gem minerals is known to occur in California. Only a few individuals and small companies produce these minerals commercially. However, thousands of amateur lapidaries and mineral collectors spend their week-ends and vacations searching for gem minerals.

During 1949, a small amount of chrysoprase and nephrite jade was mined near Porterville, Tulare County. Some nephrite came from the beaches of southern Monterey County; green tourmaline, golden and pink beryl, and kunzite from San Diego County; green beryl from Riverside County; and idocrase (californite) from Siskiyou County. The foregoing list does not include the jasper, agate, nephrite jade, californite, petrified wood, and similar polishing materials, gathered by collectors from numerous other occurrences in the state.

Gold. The California gold output in 1949 totaled 417,231 fine ounces worth $14,603,085, compared with 421,473 fine ounces worth $14,751,555 in 1948.

Gold was produced in 33 counties during 1949 and came from 242 lode mines, which produced 166,683 fine ounces worth $5,833,905; and 190 placers, which produced 250,548 fine ounces worth $8,769,180.

Mine production of gold in California, 1949, by counties.

County	Mines producing[1]		Gold	
	Lode	Placer	Fine ounces	Value
Amador	10	11	19,222	$672,770
Butte	2	10	23,454	820,890
Calaveras	11	4	3,023	105,805
El Dorado	8	12	3,114	108,990
Fresno and Humboldt[2]	----------	4	222	7,770
Imperial	1	----------	32	1,120
Inyo	44	1	4,012	140,420
Kern	25	3	5,714	199,990
Los Angeles	3	2	249	8,715
Madera	2	8	1,233	43,155
Mariposa	21	7	6,681	233,835
Merced	----------	3	12,357	432,495
Modoc	1	----------	9	315
Mono and Monterey[2]	3	----------	45	1,575
Nevada	12	12	116,483	4,076,905
Placer	3	15	1,444	50,540
Plumas	7	5	680	23,800
Riverside	6	----------	47	1,645
Sacramento	1	12	105,776	3,702,160
San Bernardino	32	3	2,550	89,250
San Diego	1	----------	3	105
San Francisco	----------	1	3	105
San Joaquin and Stanislaus[2]	----------	6	15,328	536,480
Shasta	13	4	8,008	280,280
Sierra	5	15	13,500	472,500
Siskiyou	12	22	15,218	532,630
Trinity	6	20	3,238	113,330
Tulare	----------	1	26	910
Tuolumne	12	1	372	13,020
Yuba	1	8	[3]55,188	[3]1,931,580
Totals	242	190	417,231	$14,603,085

[1] Excludes itinerant prospectors, snipers, and high-graders.
[2] Values combined to avoid disclosure of individual output.
[3] Lode gold included with Nevada County.

Nevada County led in value of gold yield for 1949, with a total of $4,076,905. Second was Sacramento County with $3,707,160; Yuba County was third with $1,931,580, followed in turn by Butte, Amador, Siskiyou, Sierra, and Merced Counties. The gold from Nevada, Amador, and Sierra Counties was mostly from the lode mines, while the gold from the other counties listed above came mainly from the placers.

The following, quoted from Merrill[2] gives an outline of activities in the California gold mining industry for 1949:

"Ranking second in output of gold in the United States in 1949, compared with first in 1948, California's production dropped 3 percent contrasted with a 21-percent rise in first-place South Dakota. According to preliminary data 61 percent of the 1949 output was from placer mines and 39 percent from lode mines. Following the pattern of recent years bucket-line dredges produced the major part of the 1949 placer gold; leading producers were Yuba Consolidated Gold Fields which operated dredges in Yuba, Butte and Siskiyou Counties and the fleet of dredges operated by Natomas Co. in the Folsom district, Sacramento County. Dragline dredging was less active in 1949 than formerly, and hydraulic and drift mines were worked sporadically only during the year. New placer developments during 1949 included Fairway Placers, a bucket-line dredge near Minersville, Trinity County and Crescent Pacific Mining Co. operation on the middle fork of the Yuba River,

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[2] Merrill, Charles White, Mine production of gold in United States in 1949: U. S. Bur. Mines Min. Market Rept. MMS 1828, p. 2.

Nevada County. Bucket-line dredges respectively of Tuolumne Gold Dredging Co. in Stanislaus County, Merced Dredging Co. in Merced County, Lancha Plana Gold Dredging Co. in Butte and Sacramento Counties and Thurman & Wright in Sacramento County closed down during 1949. Leading lode mines in 1949 were Idaho Maryland Mines Corp. and Empire Star Mines Co., Ltd. properties, largely lessee operated, in the Grass Valley-Nevada City district, Nevada County. Other producers that contributed substantially to the State total lode gold were: Central Eureka Mining Co. Old Eureka mine, Mother Lode district, Amador County; the Original Sixteen to One Mine, Inc. Original Sixteen to One mine, Alleghany district, Sierra County; Mount Gaines Mining Co. Mount Gaines mine, Hunter Valley district, Mariposa County, and Burton Bros. which operated the Cactus and Tropico mines and a custom mill in the Mojave district, Kern County."

Gypsum. During 1949, crude gypsum shipped from California deposits totaled 753,581 short tons valued at $1,852,452, compared with 962,038 short tons worth $2,354,390 shipped in 1948. Of the 1949 total, 338,340 [3] short tons were sold as an agricultural mineral to be used as a soil conditioner, compared with 394,979 short tons sold in 1948. The 1949 output came from properties in Fresno, Imperial, Kern, Kings, Riverside, San Luis Obispo, and Ventura Counties.

Gypsum production in California during 1949, by counties.

County	Short tons	Value
Fresno	12,203	$15,416
Kern	202,904	314,574
Imperial, Kings, Riverside, San Luis Obispo, Ventura*	538,474	1,522,462
Totals	753,581	$1,852,452

* Combined to avoid disclosure of individual output.

Iodine. Two companies produced iodine in California during 1948 and 1949. The iodine is extracted at four plants in Los Angeles County, from waste water produced by oil wells of the Los Angeles Basin. California is the only state in the nation in which iodine is recovered.

Iron ore. During 1949, a total of 536,525 long tons of iron ore was mined in California compared with 153,684 long tons in 1948. Shipments of iron ore from the state's deposits during 1949 totaled 584,109 long tons compared with 345,863 long tons in 1948.

The principal producing property in 1949 was Eagle Mountain mine in Riverside County. The Vulcan mine in San Bernardino County was not operating, but shipments of ore were made from stock pile. A small shipment of iron ore was made from a property in Shasta County.

Lead. The mine production of recoverable lead in California during 1949 totaled 20,636,000 pounds valued at $3,260,488, compared with 18,220,000 pounds worth $3,261,380 in 1948. The Anaconda Copper Mining Company's mine at Darwin, Inyo County, was the largest lead producer, followed by their Shoshone mine at Tecopa in the same county.

Lime. The lime manufactured in California during 1949 totaled 153,483 short tons valued at $2,516,262, as compared with 179,257 short tons worth $3,026,941 in 1948. The 1949 output came from three plants in San Bernardino County, which produced 22,092 short tons of lime worth $297,943; two plants in El Dorado County; and one plant each in Alameda, Monterey, and Tuolumne Counties.

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[3] Fertilizing materials: California Dept. Agr., Special Pub. 236, 1949.

In California,[4] during 1949, agriculture consumed 10,388 short tons of by-product lime, 1353 short tons hydrated lime, 10,495 short tons limestone shells and marl. These materials were used on the soil to correct acidity, to assist in granulation or breaking up of heavy clay soils, to promote decay of organic substances, and to assist in the formation of calcium nitrate. Pulverized limestone used as a diluent or admix in commercial fertilizers is not included in the above figures.

Mine production of recoverable lead in California during 1949, by counties.

County	Pounds	Value	County	Pounds	Value
Amador	100	$16	San Bernardino	320,700	$50,671
Calaveras	33,300	5,261	Shasta	589,900	93,204
Inyo	19,659,100	3,106,138	Tuolumne	200	32
Mono and Monterey[1]	300	47			
Nevada	900	142	Totals	20,636,000	$3,260,488
Riverside	31,500	4,977			

[1] Combined to avoid disclosure of individual output.

Lithium Minerals. Lithium-sodium phosphate was produced from the brines of Searles Lake, San Bernardino County, during 1949. This was the chief source of the nation's lithium.

Magnesite. The magnesite mined in California during 1948 and 1949 came from a single property in Santa Clara County.

Magnesium Compounds (From Sea Water and Bitterns). During 1949 a total of 27,600 short tons of MgO equivalent worth $1,770,000 was produced at California plants in Alameda, Monterey, San Diego, and San Mateo Counties. The 1948 output totaled 38,500 [5] short tons worth $2,549,000.

Manganese Ore. California produced 280 short tons of manganese ore containing 121 tons of manganese during 1949, from a property in Plumas County, and 386 short tons of ferruginous manganese ore containing 80 tons of manganese from single properties in Plumas and San Bernardino Counties. This was the first manganese ore shipped in the state since 1945.

Mercury (Quicksilver). The California output of mercury in 1949 totaled 4,493 flasks (of 76 pounds) worth $357,014. Production came from 15 properties in Fresno, Lake, Napa, San Benito, San Luis Obispo, Santa Clara, and Sonoma Counties. The 1948 production was 11,188 flasks (of 76 pounds) worth $855,770, produced from 13 properties in Del Norte, Lake, Napa, San Benito, San Luis Obispo, Santa Clara, Sonoma, and Yolo Counties. The California production in 1949 accounted for 45 percent of the national output.

Mica. During 1949, no sericite mica was reported shipped from the property near Ogilby, Imperial County, which has been producing intermittently since 1929.

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[4] Fertilizing materials: California Dept. Agr., Special Pub. 236, 1949.
[5] Totals partly estimated.

Mineral Pigments (Natural). A property near Ludlow, San Bernardino County, mined and shipped mineral pigment material during 1949. The output of this property has been small and is included in the figures for iron ore.

Mineral Water. Water from many springs and artesian wells, bottled and in part artificially carbonated, is classed as mineral water. Health and pleasure resorts are located at many hot springs in California. The water at some of the hot springs is not suitable for drinking, but is utilized for bathing. Counties from which mineral waters are bottled and sold are: Butte, Calaveras, Contra Costa, Lake, Los Angeles, Marin, Napa, Orange, Riverside, San Benito, San Bernardino, San Diego, San Francisco, San Luis Obispo, Santa Barbara, Shasta, Siskiyou, Sonoma, and Tehama. No canvass of mineral water producers is made by the U. S. Bureau of Mines.

Molybdenum. Molybdenum concentrates were produced in California as a by-product of tungsten ores. The 1949 output came from the Pine Creek mine of the U. S. Vanadium Corporation near Bishop, Inyo County.

Natural Gas. Natural gas utilized in California during 1949 was second to petroleum in value. Total output utilized was 539,550,000 thousand cubic feet, valued at $65,825,000 at the well, compared with 570,954,000 thousand cubic feet, worth $64,803,000 in 1948. The 1949 output came from wells in 21 counties and was the largest in value of any year on record, although the quantity of production in 1948 slightly surpassed that of 1949.

Natural gas production in California during 1949, by counties.

County	Thousand cubic feet	Value	County	Thousand cubic feet	Value
Fresno	77,428,000	$9,222,000	Tulare	5,325,000	$726,000
Kern	75,965,000	8,719,000	Ventura	53,619,000	5,806,000
Kings	34,661,000	4,219,000	Butte, Contra Costa, Glenn, Humboldt, Monterey, San Luis Obispo, Stanislaus, Sutter, and Yolo*	7,989,000	1,064,000
Los Angeles	94,664,000	10,661,000			
Madera	3,019,000	410,000			
Orange	29,403,000	3,439,000			
Sacramento	72,670,000	10,315,000			
San Joaquin	6,341,000	849,000			
Santa Barbara	16,228,000	1,560,000			
Solano	62,238,000	8,835,000	Totals	539,550,000	$65,825,000

* Combined to conceal the output of individual operators.

Natural Gas Liquids. Natural gasoline and cycle products produced in California during 1949 totaled 862,143,000 gallons valued at $65,827,000, compared with 844,961,000 (revised) gallons worth $62,834,000 (revised) for 1948.

Liquefied petroleum gases produced in California during 1949 totaled 275,318,000 gallons worth $19,080,000, compared with 270,103,000 (revised) gallons worth $16,527,000 (revised) for 1948.

Peat. During 1949 a total of 5,670 short tons of peat worth $35,193 was reported shipped from California properties in Contra Costa, Modoc, Orange, and San Diego Counties, compared with 6,942 short tons worth $33,265 in 1948.

Perlite. During 1949, crude perlite produced in California came from properties in Inyo and San Bernardino Counties. There was also a small output from properties in Napa and Sonoma Counties, which was not reported to the U. S. Bureau of Mines.

Several perlite expanding plants are in operation in California. Most of these plants are in the Los Angeles and San Francisco Bay areas.

Natural gas liquids production in California during 1949, by counties.

County	Natural gas gasoline		Liquefied petroleum gases	
	Gallons	Value	Gallons	Value
Fresno	27,558,000	$2,104,000	29,152,000	$2,020,000
Kern	242,369,000	18,505,000	88,869,000	6,159,000
Kings[a]	92,388,000	7,054,000	56,962,000	3,948,000
Los Angeles	254,964,000	19,467,000	46,714,000	3,237,000
Orange	124,314,000	9,492,000	9,756,000	676,000
Santa Barbara	23,573,000	1,800,000	11,756,000	815,000
Ventura	96,977,000	7,405,000	32,109,000	2,225,000
Totals	862,143,000	$65,827,000	275,318,000	$19,080,000

[a] The gas from which the natural gas gasoline and liquefied petroleum gas were reduced came from Kettleman Hills field in Kings and Fresno Counties. Most of the gasoline plants in this field are in Kings County.

Petroleum. Petroleum leads in value of all mineral substances produced in California, accounting for approximately 70 percent of the state's total in 1949. During 1949 the state's petroleum output totaled 332,839,000 barrels valued at $752,220,000, compared with 340,074,000 (revised) barrels worth $822,980,000 (revised) for 1948. Among the states of the nation, California ranks second in the output of crude oil.

Petroleum production in California for 1948 and 1949, by counties.

County	1948		1949	
	Barrels*	Value*	Barrels	Value
Fresno	45,840,000	$111,823,000	43,843,000	$107,309,000
Kern	105,421,000	253,416,000	92,045,000	204,849,000
Kings	6,551,000	17,949,000	5,156,000	13,507,000
Los Angeles	91,092,000	222,808,000	93,421,000	216,151,000
Orange	38,215,000	91,849,000	37,129,000	77,742,000
San Luis Obispo	460,000	1,207,000	2,718,000	7,302,000
Santa Barbara	23,755,000	51,947,000	24,010,000	43,875,000
Ventura	28,615,000	71,727,000	34,032,000	80,860,000
Monterey, San Benito, San Bernardino, Santa Clara and Sonoma†	125,000	254,000	485,000	625,000
Totals	340,074,000	$822,980,000	332,839,000	$752,220,000

* Revised figures for 1948.
† Combined to conceal output of individuals in each.

Platinum-Group Metals. The platinum group metals produced in California during 1949 came from gold placer operations in Butte, Merced, Sacramento, Siskiyou, Stanislaus, and Yolo Counties. The 1948 output totaled 272 ounces and came from placer operations in Butte, Mariposa, Merced, Sacramento, San Joaquin, Shasta, Siskiyou, and Yuba Counties.

Potash. Potassium salts were recovered in California during 1949 by the American Potash and Chemical Company from the brines of Searles Lake, San Bernardino County.

Pumice, Pumicite and Scoria. The output of pumice and pumicite (volcanic ash) in California during 1949 totaled 149,878 short tons valued at $799,602, compared with 196,934 short tons worth $1,110,447 in 1948.

The material coming from Calaveras, Imperial, Modoc, and part of the production from Inyo, Madera, San Bernardino, and Siskiyou Counties was pumice; the production from Amador, Tuolumne, and part of the production from Inyo, Madera, and San Bernardino Counties was pumicite or volcanic ash; part of the production from Mono and Siskiyou Counties was scoria.

Pyrites. The 1949 production of pyrites in California came from the Hornet mine at Matheson, Shasta County. This property has been the chief source of the state's pyrites for many years.

Salt. The salt produced in California during 1949 totaled 964,807 short tons valued at $4,110,271, compared with 914,035 short tons worth $3,927,722 for 1948. Of the 1949 salt output, 772,572 short tons worth $3,482,356 came from Alameda County; the remainder came from properties in Kern, Monterey, Orange, San Bernardino, and San Diego Counties.

The 1949 salt yield was the largest in both quantity and value of any year so far reported in the state.

Sand and gravel production in California, by counties, for 1949.

County	Short tons	Value
Alameda	4,466,378	$4,543,391
Butte	461,624	451,123
Calaveras	31,050	40,300
Colusa	103,616	38,195
Contra Costa	361,245	158,889
Del Norte	95,963	127,199
Fresno	734,851	772,887
Humboldt	477,191	435,643
Imperial	516,336	306,988
Inyo	55,641	22,793
Kern	495,209	588,741
Lake	117,143	78,623
Lassen	223,935	39,500
Los Angeles	11,020,272	6,848,873
Madera	5,000	2,040
Mariposa	43,720	31,907
Modoc	165,229	48,826
Monterey	775,084	1,248,268
Orange	1,074,181	881,790
Plumas	96,776	78,412
Riverside	1,454,745	1,255,667
Sacramento	1,322,605	1,228,163
San Benito	61,317	42,136
San Bernardino	1,285,262	1,063,078
San Diego	1,461,872	1,906,886
San Joaquin	1,424,586	1,349,904
San Luis Obispo	152,869	174,513
Santa Barbara	391,069	[1]
Santa Clara	402,756	[1]
Santa Cruz	815,493	687,616
Shasta	634,057	549,514
Sierra	52,975	57,043
Siskiyou	160,627	155,991
Stanislaus	298,347	296,073
Sutter	333,133	258,197
Trinity	161,294	118,907
Tulare	815,109	815,148
Ventura	745,421	558,127
Yolo	412,375	165,226
Alpine, Amador, El Dorado, Glenn, Kings, Marin, Mendocino, Merced, Mono, Napa, Nevada, Placer, San Mateo, Solano, Sonoma, Tehama, Tuolumne, Yuba[1]	2,573,460	2,772,347
Totals	36,279,816	$30,198,924

[1] Values combined to avoid disclosure of individual output.

Sand and Gravel. During 1949 in California a total of 36,279,816 short tons of sand and gravel was produced, valued at $30,198,924, compared with 33,786,520 short tons worth $30,592,965 in 1948. Sand and gravel was produced in every county in the state, with the exception of San Francisco County.

Serpentine. Serpentine has been quarried in California for use as a building stone (verde antique), as an admix in concrete, and as a source of magnesium in the manufacture of epsom salts. From 1946 to 1948, it was also used in the manufacture of a fertilizer called Thermo-phos. Serpentine produced near Almaden, Santa Clara County, is fused with phosphate rock in a plant at Permanente, California, to make a phosphate fertilizer for use on land deficient in phosphorus and magnesium. No production was made in 1949.

Silica. Quartz was mined in California during 1949, from a single property in Kern County, ganister (quartzite) from a property in San Bernardino County, and glass sand from properties in Monterey and Riverside Counties. The annual details on quartz and quartzite are included with *Other Minerals* in the table *Quantity and Value of Mineral Substances,* and glass sand is included with *Sand and Gravel.*

Silver. The silver output in California during 1949 totaled 783,880 fine ounces worth $709,451, compared with 724,771 fine ounces worth $655,954 in 1948.

Mine production of silver in California during 1949, by counties.

County	Silver	
	Fine ounces	Value
Amador	4,212	$3,812
Butte	1,574	1,425
Calaveras	9,034	8,176
El Dorado	787	712
Fresno and Humboldt[1]	32	29
Imperial	9	8
Inyo	591,391	535,239
Kern	17,555	15,888
Los Angeles	123	111
Madera	342	309
Mariposa	1,722	1,558
Merced	1,139	1,031
Modoc	3	3
Mono and Monterey[1]	1,166	1,055
Nevada	34,962	31,642
Placer	1,348	1,220
Plumas	80	72
Riverside	951	861
Sacramento	4,934	4,466
San Bernardino	26,237	23,746
San Diego	2	2
San Francisco	1	1
San Joaquin and Stanislaus[1]	1,414	1,280
Shasta	76,444	69,185
Sierra	2,606	2,359
Siskiyou	1,987	1,798
Trinity	423	383
Tulare	4	4
Tuolumne	78	71
Yuba	[2]3,320	[2]3,005
Totals	783,880	$709,451

[1] Combined to avoid disclosure of individual output.
[2] Lode silver included with Nevada County.

Of the 1949 output of silver, 766,083 fine ounces came from the lode mines, and 17,797 fine ounces from the placer mines.

Slate. Slate mined in California during 1949 came from properties in El Dorado and Tuolumne Counties. The properties that reported shipments of slate from Inyo and Mariposa Counties during 1948 reported no production in 1949.

Stone. During 1949 California produced a total of 11,373,700 short tons of stone (including crushed rock, rubble, rip rap, dolomite, industrial limestone; and dimension stone, such as basalt, granite, limestone, and sandstone) worth $12,594,048, as compared with 11,936,240 short tons worth $13,155,454 for 1948.

Stone production of California during 1949, by counties.

County	Short tons	Value
Alameda	1,113,600	$963,059
Contra Costa	547,680	603,310
Del Norte	13,650	[1]
El Dorado	155,470	440,674
Fresno	310,050	532,399
Humboldt	45,050	[1]
Los Angeles	3,251,720	2,511,510
Mono	17,560	8,778
Monterey	131,710	231,297
Napa	217,870	269,412
Orange	155,140	[1]
Placer	30,110	107,850
Riverside	51,780	75,162
Sacramento	204,380	236,042
San Bernardino	528,280	961,742
San Diego	71,240	159,645
San Luis Obispo	166,060	269,700
San Mateo	662,350	767,229
Santa Barbara	201,640	[1]
Santa Clara	383,400	312,232
Siskiyou	237,830	123,477
Solano	73,580	[1]
Sonoma	117,320	144,697
Trinity	39,510	34,957
Tuolumne	39,270	268,234
Amador, Butte, Imperial, Inyo, Kern, Marin, Mendocino, Plumas, San Benito, San Joaquin, Santa Cruz, Shasta, Tehama, Tulare, Ventura, Yolo[1]	2,607,450	3,572,642
Totals	11,373,700	$12,594,048

[1] Values combined to avoid disclosure of individual output.

Sulfur. Sulfur mined in California during 1949, totaled 1,302 short tons worth $26,444, and came from a single property in Inyo County. Sulfur was mined in 1948 from single properties in Alpine and Inyo Counties.

Soda. Sodium carbonate (soda ash and trona) produced in California during 1949, totaled 200,496 short tons worth $4,163,714, compared with 288,769 short tons worth $6,623,280 in 1948. The 1949 output came from two properties in Inyo County and two properties in San Bernardino County.

Sodium sulfate (salt cake) produced in California during 1949 and 1948 came from two properties in San Bernardino County. The annual details are included with *Other Minerals* in the table *Quantity and Value of Mineral Substances.*

Talc, Soapstone, and Pyrophyllite. Talc, soapstone, and pyrophyllite mined and shipped in California during 1949, totaled 83,359 short tons valued at $1,434,046, and came from properties in El Dorado, Inyo, Los Angeles, Mono, San Bernardino, and San Diego Counties. The 1948 output totaled 98,681 short tons, worth $1,773,764. The material from El Dorado and Los Angeles Counties was soapstone. Part of the production from San Bernardino County and Inyo County was talc. The material from Mono and San Diego Counties, and part of the production from Inyo and San Bernardino Counties was pyrophyllite.

Talc, soapstone, and pyrophyllite production in California in 1949, by counties.

County	Short tons	Value
Inyo	26,295	$340,367
San Bernardino	46,607	991,444
El Dorado, Los Angeles, Mono, San Diego*	10,457	102,235
Totals	83,359	$1,434,046

* Combined to avoid disclosure of individual output.

Titanium. During 1949, titanium concentrate (ilmenite) was produced in California from a single property in Sand Canyon near Saugus, Los Angeles County.

Tungsten. High-grade tungsten concentrates mined in California and shipped during 1949 totaled 952 short tons (60 percent WO_3 basis), or 57,135 units.

These concentrates came from properties in Alpine, Fresno, Inyo, Kern, Madera, Mono, and San Bernardino Counties. The 1948 shipments totaled 1,767 short tons (60 percent WO_3 basis), or 106,006 units, and came from properties in Alpine, Fresno, Inyo, Kern, Madera, Mono, San Bernardino, and Tulare Counties.

Zinc. The mine production of recoverable zinc in California during 1949 totaled 14,418,000 pounds valued at $1,787,832, compared with 10,650,000 pounds worth $1,416,450 in 1948.

Mine production of recoverable zinc during 1949, by counties.

County	Pounds	Value
Calaveras	726,700	$90,111
Inyo	8,952,200	1,110,073
San Bernardino	618,300	76,669
Shasta	4,120,800	510,979
Totals	14,418,000	$1,787,832

Value of mineral production in California, 1948 and 1949, by counties.†

County	1948	1949
Alameda	$8,771,793	$9,696,590
Alpine	[1]	[1]
Amador	*955,626	904,789
Butte	1,284,737	1,415,097
Calaveras	4,662,145	5,047,431
Colusa	20,756	38,195
Contra Costa	1,255,576	1,249,973
Del Norte	186,902	144,969
El Dorado	1,758,799	1,550,024
Fresno	*124,104,502	122,001,066
Glenn	[2]271,276	[2]336,008
Humboldt	407,996	636,604
Imperial	*2,092,508	1,692,930
Inyo	10,286,796	7,372,421
Kern	*292,230,122	251,749,473
Kings	*35,283,310	28,792,437
Lake	116,787	78,623
Lassen	38,156	170,580
Los Angeles	*275,698,293	262,694,189
Madera	446,627	599,296
Marin	389,245	741,278
Mariposa	280,739	325,732
Mendocino	*[3]491,130	[3]502,027
Merced	869,757	834,482
Modoc	145,490	59,159
Mono	355,497	338,673
Monterey	4,196,755	3,906,363
Napa	303,385	395,251
Nevada	[1]3,659,073	[1]4,033,957
Orange	*105,454,783	92,505,148
Placer	512,671	454,817
Plumas	32,975	177,036
Riverside	9,269,937	10,015,932
Sacramento	16,737,925	15,544,122
San Benito	$2,803,469	$2,332,368
San Bernardino	44,640,646	39,486,593
San Diego	2,594,065	2,427,135
San Francisco	[3]	[3]
San Joaquin	3,077,835	2,502,537
San Luis Obispo	*1,427,990	7,751,072
San Mateo	5,707,031	5,267,012
Santa Barbara	*60,494,770	52,629,378
Santa Clara	13,317,067	14,566,606
Santa Cruz	4,024,125	4,671,289
Shasta	1,680,434	2,127,372
Sierra	384,223	531,902
Siskiyou	1,012,137	886,098
Solano	8,903,771	9,073,140
Sonoma	1,029,437	1,005,526
Stanislaus	954,234	653,482
Sutter	130,447	356,096
Tehama	[2]	[2]
Trinity	311,010	267,577
Tulare	2,057,745	1,738,887
Tuolumne	850,342	783,822
Ventura	*86,608,246	97,103,752
Yolo	144,870	443,044
Yuba	2,226,195	2,261,095
Totals	*$1,146,952,158	$1,074,870,455
Less clays sold or used for cement (not entirely separable by counties)	—561,312	—503,968
Gem stones (not separable by counties) conjectural	+20,000	+50,000
Total California (rounded)	*$1,146,411,000	$1,074,416,000

† These figures furnished by U. S. Bureau of Mines in cooperation with California State Division of Mines.

* Revised figures.

[1] Output of Alpine County is included with Nevada County.

[2] Output of Tehama County is included with Glenn County.

[3] Output of San Francisco County is included with Mendocino County.

DETAILS OF MINERAL PRODUCTION FOR EACH COUNTY, 1948 AND 1949
Figures furnished by U.S. Bureau of Mines
in cooperation with California State Division of Mines

PRODUCT		1948		1949	
		QUANTITY	VALUE	QUANTITY	VALUE
ALAMEDA COUNTY					
Clays	short tons	14,404	$ 16,109	17,837	$ 21,017
Salt (common)	do	663,108	3,091,370	772,572	3,482,356
Sand and gravel	do	3,896,600	4,026,285	4,466,378	4,543,391
Stone	do	1,002,200	742,900	1,113,600	963,059
Unapportioned: Bromine, lime, and magnesium compounds		-------	895,129	-------	686,767
TOTAL VALUE		-------	8,771,793	-------	9,696,590
ALPINE COUNTY					
1948: Copper, gold, silver, sulfur ore, and tungsten concentrates					
1949: Sand and gravel and tungsten concentrates					
AMADOR COUNTY					
Clays	short tons	a/189,884	a/625,537	84,286	160,061
Coal (lignite)	do	1,450	14,500	3,900	39,000
Copper	pounds	-------	-------	300	59
Gold	troy ounces	6,614	231,490	19,222	672,770
Lead	pounds	-------	-------	100	16
Sand and gravel	short tons	34,490	65,476	(1)	(1)
Silver	troy ounces	2,252	2,038	4,212	3,812
Stone	short tons	21,270	(1)	(1)	(1)
Unapportioned: Pumice and minerals indicated by footnote 1		-------	16,585	-------	29,071
TOTAL VALUE		-------	*955,626	-------	904,789

PRODUCT		1948		1949	
		QUANTITY	VALUE	QUANTITY	VALUE
BUTTE COUNTY					
Chromite	short tons	------	$ ------	162	$ (1)
Gold	troy ounces	26,137	914,795	23,454	820,890
Sand and gravel	short tons	148,990	192,798	461,624	451,123
Silver	troy ounces	1,990	1,801	1,574	1,425
Stone	short tons	224,770	158,895	(1)	(1)
Unapportioned: Natural gas, platinum-group metals, and minerals indicated by footnote 1		------	16,448	------	141,659
TOTAL VALUE		------	1,284,737	------	1,415,097
CALAVERAS COUNTY					
Copper	pounds	------	------	76,500	15,070
Gold	troy ounces	1,196	41,860	3,023	105,805
Lead	pounds	2,000	358	33,300	5,261
Sand and gravel	short tons	113,871	204,507	31,050	40,300
Silver	troy ounces	640	579	9,034	8,176
Zinc	pounds	------	------	726,700	90,111
Unapportioned: Cement, clays, and pumice		------	4,414,841	------	4,782,708
TOTAL VALUE		------	4,662,145	------	5,047,431
COLUSA COUNTY					
Gold	troy ounces	2	70	------	------
Sand and gravel	short tons	65,711	20,685	103,616	38,195
Silver	troy ounces	1	1	------	------
TOTAL VALUE		------	20,756	------	38,195

PRODUCT		1948		1949	
		QUANTITY	VALUE	QUANTITY	VALUE
CONTRA COSTA COUNTY					
Sand and gravel	short tons	372,013	$ 252,229	361,245	$ 158,889
Stone	do	499,110	586,904	547,680	603,310
Unapportioned: Clays, natural gas, peat and pumice (1948)		------	416,443	------	487,774
TOTAL VALUE		------	1,255,576	------	1,249,973
DEL NORTE COUNTY					
Chromite	short tons	274	(1)	214	(1)
Mercury	flasks	5	382	------	------
Sand and gravel	short tons	(1)	(1)	95,963	127,199
Stone	do	(1)	(1)	13,650	(1)
Unapportioned: Minerals indicated by footnote 1		------	186,520	------	17,770
TOTAL VALUE		------	186,902	------	144,969
EL DORADO COUNTY					
Copper	pounds	72,000	15,624	------	------
Gold	troy ounces	2,592	90,720	3,114	108,990
Silver	troy ounces	1,391	1,259	787	712
Stone	short tons	176,130	490,086	155,470	440,674
Unapportioned: Lime, sand and gravel, slate and soapstone		------	1,161,110	------	999,648
TOTAL VALUE		------	1,758,799	------	1,550,024

PRODUCT		1948		1949	
		QUANTITY	VALUE	QUANTITY	VALUE
FRESNO COUNTY					
Gypsum (crude)	short tons	15,443	$ 23,271	12,203	$ 15,416
Mercury	flasks	------	------	7	556
Natural gas	thousand cubic feet	69,644,000	7,224,000	77,428,000	9,222,000
Natural-gas liquids:					
Natural gasoline 2/	gallons	*26,703,000	*1,986,000	27,558,000	2,104,000
Liquefied petroleum gases 2/	do	*22,300,000	*1,364,000	29,152,000	2,020,000
Petroleum	barrels	*45,840,000	*111,823,000	43,843,000	107,309,000
Sand and gravel	short tons	932,804	1,022,024	734,851	772,887
Silver	troy ounces	(1)	(1)	(1)	(1)
Stone	short tons	416,530	618,459	310,050	532,399
Tungsten concentrates (60% WO_3 basis)	do	11	15,858	(1)	(1)
Unapportioned: Clays, gold and minerals indicated by footnote 1		------	27,890	------	24,808
TOTAL VALUE		------	*124,104,502	------	122,001,066
GLENN COUNTY					
1948: Natural gas, sand and gravel					
1949: Natural gas, sand and gravel					
HUMBOLDT COUNTY					
Sand and gravel	short tons	359,243	293,016	477,191	435,643
Stone	short tons	23,310	(1)	45,050	(1)
Unapportioned: Clays, gold, natural gas, silver, and minerals indicated by footnote 1		------	114,980	------	200,961
TOTAL VALUE		------	407,996	------	636,604

PRODUCT		1948		1949	
		QUANTITY	VALUE	QUANTITY	VALUE
IMPERIAL COUNTY					
Carbon dioxide (natural)	thousand cubic feet	a/(1)	a/(1)	135,260	(1)
Gold	troy ounces	171	$ 5,985	32	$ 1,120
Sand and gravel	short tons	488,277	(1)	516,336	306,988
Silver	troy ounces	93	84	9	8
Unapportioned: Crude gypsum, mica scrap, pumice (1949) stone, and minerals indicated by footnote 1		------	*2,086,439	------	1,384,814
TOTAL VALUE		------	*2,092,508	------	1,692,930
INYO COUNTY					
Antimony ore	short tons	5	1,467	------	------
Copper	pounds	598,000	129,766	421,300	82,996
Gold	troy ounces	1,794	62,790	4,012	140,420
Lead	pounds	17,240,000	3,085,960	19,659,100	3,106,138
Pumice and pumicite	short tons	(1)	(1)	39,100	125,802
Sand and gravel	do	105,176	111,937	55,641	22,793
Silver	troy ounces	573,283	518,850	591,391	535,239
Sulfur ore	long tons	(1)	(1)	1,302	26,444
Talc and pyrophyllite	short tons	33,546	471,596	26,295	340,367
Zinc	pounds	9,320,000	1,239,560	8,952,200	1,110,073
Unapportioned: Boron minerals, clays (including fuller's earth), diatomite, molybdenum concentrates, perlite (1949), slate (1948), sodium salts, stone, tungsten concentrates, and minerals indicated by footnote 1		------	4,664,870	------	1,882,149
TOTAL VALUE		------	10,286,796	------	7,372,421

PRODUCT		1948		1949	
		QUANTITY	VALUE	QUANTITY	VALUE
KERN COUNTY					
Clays	short tons	215,953	$ 768,280	202,509	$ 699,635
Gold	troy ounces	6,176	216,160	5,714	199,990
Gypsum (crude)	short tons	271,908	414,233	202,904	314,574
Natural gas	thousand cubic feet	84,803,000	8,414,000	75,965,000	8,719,000
Natural-gas liquids:					
Natural gasoline	gallons	*144,087,000	*10,716,000	242,369,000	18,505,000
Liquefied petroleum gases	do	*107,985,000	*6,607,000	88,869,000	6,159,000
Petroleum	barrels	*105,421,000	*253,416,000	92,045,000	204,849,000
Sand and gravel	short tons	581,495	663,945	495,209	588,741
Silver	troy ounces	13,509	12,226	17,555	15,888
Unapportioned: Boron minerals, cement, feldspar (1948), pumice and pumicite (1948), quartz (1948), common salt (1948), stone (1949), and tungsten concentrates		------	11,002,278	------	11,698,645
TOTAL VALUE		------	*292,230,122	------	251,749,473
KINGS COUNTY					
Natural gas	thousand cubic feet	40,310,000	$ 4,545,000	34,661,000	$ 4,219,000
Natural-gas liquids:					
Natural gasoline 2/	gallons	*116,424,000	*8,656,000	92,388,000	7,054,000
Liquefied petroleum gases 2/	do	*66,593,000	*4,075,000	56,962,000	3,948,000
Petroleum	barrels	*6,551,000	*17,949,000	5,156,000	13,507,000
Unapportioned: Gypsum (crude), sand and gravel		------	58,310	------	64,437
TOTAL VALUE		------	*35,283,310	------	28,792,437

PRODUCT		1948		1949	
		QUANTITY	VALUE	QUANTITY	VALUE
LAKE COUNTY					
Sand and gravel	short tons	125,008	$ (1)	117,143	$ 78,623
Stone	do	2,430	(1)	------	------
Unapportioned: Mercury and minerals indicated by footnote 1		------	116,787	------	------
TOTAL VALUE		------	116,787	------	78,623
LASSEN COUNTY					
Gold	troy ounces	121	4,235	------	------
Sand and gravel	short tons	(1)	(1)	223,935	39,500
Silver	troy ounces	102	92	------	------
Stone	short tons	(1)	(1)	57,960	131,080
Unapportioned: Minerals indicated by footnote 1		------	33,829	------	------
TOTAL VALUE		------	38,156	------	170,580
LOS ANGELES COUNTY					
Clays	short tons	491,167	368,784	402,853	299,810
Gold	troy ounces	215	7,525	249	8,715
Natural gas	thousand cubic feet	102,783,000	11,588,000	94,664,000	10,661,000
Natural-gas liquids					
Natural gasoline	gallons.	*314,817,000	*23,411,000	254,964,000	19,467,000
Liquefied petroleum gases	do	*20,016,000	*1,225,000	46,714,000	3,237,000
Petroleum	barrels	*91,092,000	*222,808,000	93,421,000	216,151,000
Sand and gravel	short tons	11,909,517	8,085,435	11,020,272	6,848,873
Silver	troy ounces	36	33	123	111
Stone	short tons	4,425,270	4,323,469	3,251,720	2,511,510
Unapportioned: Cement, diatomite, iodine, soapstone, and titanium concentrates (ilmenite)		------	3,881,047	------	3,509,170
TOTAL VALUE		------	*275,698,293	------	262,694,189

PRODUCT		1948		1949	
		QUANTITY	VALUE	QUANTITY	VALUE
MADERA COUNTY					
Copper	pounds	10,000	$ 2,170	------	$ ------
Gold	troy ounces	(1)	(1)	1,233	43,155
Natural gas	thousand cubic feet	(1)	(1)	3,019,000	(1)
Pumice and pumicite	short tons	8,311	82,719	7,940	81,815
Sand and gravel	do	26,399	19,040	5,000	2,040
Silver	troy ounces	(1)	(1)	342	309
Tungsten concentrates (60% WO_3 basis)	short tons	58	(1)	(1)	(1)
Unapportioned: Feldspar (1949), and minerals indicated by footnote 1		------	342,698	------	471,977
TOTAL VALUE		------	446,627	------	599,296
MARIN COUNTY					
1948: Clays, sand and gravel, and stone					
1949: Clays, sand and gravel, and stone					
MARIPOSA COUNTY					
Copper	pounds	------	------	200	39
Gold	troy ounces	7,525	263,375	6,681	233,835
Sand and gravel	short tons	17,127	13,331	43,720	31,907
Silver	troy ounces	2,166	1,960	1,722	1,558
Unapportioned: Barite, platinum-group metals (1948), quartz (1949), slate (1948), and stone (1949)		------	2,073	------	58,393
TOTAL VALUE		------	280,739	------	325,732

PRODUCT		1948		1949	
		QUANTITY	VALUE	QUANTITY	VALUE
MENDOCINO COUNTY					
1948: Natural carbon dioxide, sand and gravel					
1949: Natural carbon dioxide, sand and gravel, stone.					
MERCED COUNTY					
1948: Gold, platinum-group metals, sand and gravel, and silver					
1949: Gold, platinum-group metals, sand and gravel, and silver					
MODOC COUNTY					
Gold	troy ounces	141	$ 4,935	9	$ 315
Pumice	short tons	14,165	79,095	7,098	10,015
Sand and gravel	do	114,018	61,394	165,229	48,826
Silver	troy ounces	73	66	3	3
TOTAL VALUE		------	145,490	------	59,159
MONO COUNTY					
Copper	pounds	------	------	(1)	(1)
Gold	troy ounces	63	2,205	(1)	(1)
Lead	pounds	4,000	716	(1)	(1)
Pumice	short tons	8,582	257,335	(1)	(1)
Silver	troy ounces	788	713	(1)	(1)
Stone	short tons	------	------	17,560	8,778
Tungsten concentrates (60% WO_3 basis)	do	------	------	9	(1)
Unapportioned: Pyrophyllite, sand and gravel, and minerals indicated by footnote 1		------	94,528	------	329,895
TOTAL VALUE		------	355,497	------	338,673

PRODUCT		1948		1949	
		QUANTITY	VALUE	QUANTITY	VALUE
MONTEREY COUNTY					
Gold	troy ounces	24	$ 840	(1)	$ (1)
Sand and gravel	short tons	808,160	1,525,600	775,084	1,248,268
Silver	troy ounces	6	5	(1)	(1)
Stone	short tons	197,150	281,166	131,710	231,297
Unapportioned: Lime, magnesium compounds, natural gas (1949), petroleum, common salt, ground sand and sandstone, and minerals indicated by footnote 1		------	2,389,144	------	2,426,798
TOTAL VALUE		------	4,196,755	------	3,906,363
NAPA COUNTY					
Gold	troy ounces	2	70	------	------
Sand and gravel	short tons	37,670	32,600	(1)	(1)
Silver	troy ounces	29	26	------	------
Stone	short tons	58,130	78,512	217,870	269,412
Unapportioned: Mercury, perlite (1948), pumice and pumicite, and minerals indicated by footnote 1		------	192,177	------	125,839
TOTAL VALUE		------	303,385	------	395,251
NEVADA COUNTY					
1948: Gold, sand and gravel, silver					
1949: Gold, lead, sand and gravel, silver					

PRODUCT		1948		1949	
		QUANTITY	VALUE	QUANTITY	VALUE
ORANGE COUNTY					
Clays	short tons	19,292	$ 74,984	20,835	$ 87,932
Natural gas	thousand cubic feet	30,844,000	3,338,000	29,403,000	3,439,000
Natural-gas liquids:					
Natural gasoline	gallons	*115,725,000	*8,606,000	124,314,000	9,492,000
Liquefied petroleum gases	do	*9,802,000	*600,000	9,756,000	676,000
Peat	short tons	(1)	(1)	2,194	13,123
Petroleum	barrels	*38,215,000	*91,849,000	37,129,000	77,742,000
Sand and gravel	short tons	908,737	813,411	1,074,181	881,790
Stone	do	116,130	(1)	155,140	(1)
Unapportioned: Common salt and minerals indicated by footnote 1		------	173,388	------	173,303
TOTAL VALUE		------	*105,454,783	------	92,505,148
PLACER COUNTY					
Gold	troy ounces	1,330	46,550	1,444	50,540
Silver	do	1,503	1,360	1,348	1,220
Stone	short tons	(1)	(1)	30,110	107,850
Unapportioned: Asbestos (1948), clays, sand and gravel, and minerals indicated by footnote 1		------	464,761	------	295,207
TOTAL VALUE		------	512,671	------	454,817

PRODUCT		1948		1949	
		QUANTITY	VALUE	QUANTITY	VALUE
PLUMAS COUNTY					
Copper	pounds	------	$ ------	3,500	$ 690
Gold	troy ounces	699	24,465	680	23,800
Manganese ore (35% or more Mn)	short tons	------	------	280	(1)
Manganiferous ore (5 to 35% Mn)	do	------	------	248	(1)
Sand and gravel	do	18,300	8,450	96,776	78,412
Silver	troy ounces	66	60	80	72
Unapportioned: Barite (1949), and stone (1949)		------	------	------	74,062
TOTAL VALUE		------	32,975	------	177,036
RIVERSIDE COUNTY					
Clays	short tons	339,996	562,244	293,765	585,657
Copper	pounds	------	------	5,100	1,005
Gold	troy ounces	4	140	47	1,645
Iron ore	long tons	66,617	(1)	526,840	(1)
Lead	pounds	2,000	358	31,500	4,977
Sand and gravel	short tons	802,621	482,844	1,454,745	1,255,667
Silver	troy ounces	101	91	951	861
Stone	short tons	7,160	12,562	51,780	75,162
Unapportioned: Cement, crude gypsum, and minerals indicated by footnote 1		------	8,211,698	------	8,090,958
TOTAL VALUE		------	9,269,937	------	10,015,932
SACRAMENTO COUNTY					
Clays	short tons	23,495	(1)	28,452	(1)
Gold	troy ounces	118,152	4,135,320	105,776	3,702,160
Natural gas	thousand cubic feet	81,791,000	10,874,000	72,670,000	10,315,000
Platinum-group metals	troy ounces	71	(1)	(1)	(1)
Sand and gravel	short tons	1,453,173	1,353,347	1,322,605	1,228,163
Silver	troy ounces	6,491	5,875	4,934	4,466
Stone	short tons	(1)	(1)	204,380	236,042
Unapportioned: Minerals indicated by footnote 1		------	369,383	------	58,291
TOTAL VALUE		------	16,737,925	------	15,544,122

PRODUCT		1948		1949	
		QUANTITY	VALUE	QUANTITY	VALUE
SAN BENITO COUNTY					
Mercury	flasks	(1)	$ (1)	394	$ 31,307
Sand and gravel	short tons	(1)	(1)	61,317	42,139
Unapportioned: Cement, clays, petroleum, stone, and minerals indicated by footnote 1		------	2,803,469	------	2,258,922
TOTAL VALUE		------	2,803,469	------	2,332,368
SAN BERNARDINO COUNTY					
Calcium chloride	short tons	10,009	167,610	11,166	204,024
Clays	do	165,303	386,355	139,376	414,530
Copper	pounds	118,000	25,606	135,500	26,694
Gold	troy ounces	1,518	53,130	2,550	89,250
Iron ore	long tons	279,246	(1)	55,883	(1)
Lead	pounds	838,000	150,002	320,700	50,671
Lime	short tons	27,393	405,411	22,092	297,943
Manganiferous ore (5 to 35% Mn)	do	------	------	138	(1)
Pumice and pumicite	do	(1)	(1)	1,960	42,136
Sand and gravel	do	1,671,019	1,560,323	1,285,262	1,063,078
Silver	troy ounces	57,538	52,075	26,237	23,746
Stone	short tons	1,195,970	1,563,225	528,280	961,742
Talc	do	52,622	1,160,255	46,607	991,444
Tungsten concentrates (60% WO_3 basis)	do	263	(1)	141	(1)
Zinc	pounds	438,000	58,254	618,300	76,669
Unapportioned: Boron minerals, bromine, cement, feldspar, lithium minerals, perlite (1949), petroleum, potassium salts, pyrophyllite (1949), quartz (1948) salt (common) sodium salts, and minerals indicated by footnote 1		------	39,058,400	------	35,244,666
TOTAL VALUE		------	44,640,646	------	39,486,593

PRODUCT		1948		1949	
		QUANTITY	VALUE	QUANTITY	VALUE
SAN DIEGO COUNTY					
Clays	short tons	35,222	$ 60,922	------	$ ------
Gold	troy ounces	8	280	3	105
Sand and gravel	short tons	1,395,701	1,829,989	1,461,872	1,906,886
Silver	troy ounces	3	3	2	2
Stone	short tons	91,570	280,626	71,240	159,645
Unapportioned: Abrasive stones(pebbles for grinding) magnesium compounds, peat (1949), pyrophyllite, common salt		------	422,245	------	360,497
TOTAL VALUE		------	2,594,065	------	2,427,135
SAN FRANCISCO COUNTY					
1948: Stone 1949: Gold and silver					
SAN JOAQUIN COUNTY					
Clays	short tons	18,184	14,259	19,803	15,557
Natural gas	thousand cubic feet	8,277,000	1,313,000	6,341,000	849,000
Sand and gravel	short tons	1,679,808	1,617,023	1,424,586	1,349,904
Unapportioned: Gold, platinum-group metals (1948), silver, and stone		------	133,553	------	288,076
TOTAL VALUE		------	3,077,835	------	2,502,537

PRODUCT	1948		1949	
	QUANTITY	VALUE	QUANTITY	VALUE
SAN LUIS OBISPO COUNTY				
Mercury flasks	(1)	$ (1)	2	$ 159
Petroleum barrels	460,000	*1,207,000	2,718,000	7,302,000
Sand and gravel short tons	165,064	205,053	152,869	174,513
Stone do	(1)	(1)	166,060	269,700
Unapportioned: Clays (1948), gypsum (1949), natural gas (1949), pumicite (1948), and minerals indicated by footnote 1	------	15,937	------	4,700
TOTAL VALUE	------	*1,427,990	------	7,751,072
SAN MATEO COUNTY				
Stone short tons	780,390	738,085	662,350	767,229
Unapportioned: Cement, clays, magnesium compounds, sand and gravel	------	4,968,946	------	4,499,783
TOTAL VALUE	------	5,707,031	------	5,267,012
SANTA BARBARA COUNTY				
Natural gas thousand cubic feet	20,329,000	1,925,000	16,228,000	1,560,000
Natural-gas liquids:				
Natural gasoline 3/ gallons	*25,062,000	*1,864,000	23,573,000	1,800,000
Liquefied petroleum gases 3/ do	*8,433,000	*516,000	11,756,000	815,000
Petroleum barrels	*23,755,000	*51,947,000	24,010,000	43,875,000
Sand and gravel short tons	185,629	(1)	391,069	(1)
Stone do	301,890	(1)	201,640	(1)
Unapportioned: Clays, diatomite, and minerals indicated by footnote 1	------	4,242,770	------	4,579,378
TOTAL VALUE	------	*60,494,770	------	52,629,378

PRODUCT		1948		1949	
		QUANTITY	VALUE	QUANTITY	VALUE
SANTA CLARA COUNTY					
Clays	short tons	177,780	$ (1)	200,024	$ (1)
Sand and gravel	short tons	457,451	(1)	402,756	(1)
Stone	do	255,040	189,241	283,400	312,232
Unapportioned: Cement, magnesite, mercury, petroleum, and minerals indicated by footnote 1		------	13,127,826	------	14,254,374
TOTAL VALUE		------	13,317,067	------	14,566,606
SANTA CRUZ COUNTY					
Sand and gravel	short tons	(1)	(1)	815,493	687,616
Unapportioned: Cement, clays, stone, and minerals indicated by footnote 1		------	4,024,125	------	3,983,673
TOTAL VALUE		------	4,024,125	------	4,671,289
SHASTA COUNTY					
Copper	pounds	156,000	33,852	653,900	128,818
Gold	troy ounces	11,538	403,830	8,008	280,280
Lead	pounds	106,000	18,974	589,900	93,204
Sand and gravel	short tons	490,722	440,953	634,057	549,514
Silver	troy ounces	18,935	17,137	76,444	69,185
Stone	short tons	128,410	(1)	(1)	(1)
Zinc	pounds	892,000	118,636	4,120,800	510,979
Unapportioned: Asbestos, iron ore (1949), platinum-group metals (1948), pyrites, and minerals indicated by footnote 1		------	647,052	------	495,392
TOTAL VALUE		------	1,680,434	------	2,127,372

PRODUCT		1948		1949	
		QUANTITY	VALUE	QUANTITY	VALUE
SIERRA COUNTY					
Copper	pounds	2,000	$ 434	------	$ ------
Gold	troy ounces	10,430	365,050	13,500	472,500
Lead	pounds	28,000	5,012	------	------
Sand and gravel	short tons	33,000	11,550	52,975	57,043
Silver	troy ounces	2,405	2,177	2,606	2,359
TOTAL VALUE		------	384,223	------	531,902
SISKIYOU COUNTY					
Copper	pounds	------	------	1,600	315
Gold	troy ounces	21,226	742,910	15,218	532,630
Pumice	short tons	35,577	173,136	21,265	70,267
Sand and gravel	do	(1)	(1)	160,627	155,991
Silver	troy ounces	2,757	2,495	1,987	1,798
Stone	short tons	177,770	57,642	237,830	123,477
Unapportioned: Diatomite, platinum-group metals, and minerals indicated by footnote 1		------	35,954	------	1,620
TOTAL VALUE		------	1,012,137	------	886,098
SOLANO COUNTY					
Natural gas	thousand cubic feet	66,212,000	8,746,000	62,238,000	8,835,000
Stone	short tons	(1)	(1)	73,580	(1)
Unapportioned: Sand and gravel, and minerals indicated by footnote 1		------	157,771	------	238,140
TOTAL VALUE		------	8,903,771	------	9,073,140

PRODUCT	1948		1949	
	QUANTITY	VALUE	QUANTITY	VALUE
SONOMA COUNTY				
Stone short tons	135,690	$ 169,636	117,320	$ 144,697
Unapportioned: Mercury, natural gas (1948), petroleum, sand and gravel and minerals indicated by footnote 1	------	859,801	------	860,829
TOTAL VALUE	------	1,029,437	------	1,005,526
STANISLAUS COUNTY				
Pumicite short tons	2,066	3,840	------	------
Sand and gravel do	364,719	454,660	298,347	296,073
Unapportioned: Clays, diatomite (1949), gold, natural gas, platinum-group metals (1949), and silver	------	495,734	------	357,409
TOTAL VALUE	------	954,234	------	653,482
SUTTER COUNTY				
Sand and gravel short tons	(1)	(1)	333,133	258,197
Unapportioned: Clays, natural gas and minerals indicated by footnote 1	------	130,447	------	97,899
TOTAL VALUE	------	130,447	------	356,096
TEHAMA COUNTY				
1948: Sand and gravel				
1949: Chromite, sand and gravel, stone.				

PRODUCT		1948		1949	
		QUANTITY	VALUE	QUANTITY	VALUE
TRINITY COUNTY					
Gold	troy ounces	7,930	$ 277,550	3,238	$ 113,330
Sand and gravel	short tons	8,845	12,025	161,294	118,907
Silver	troy ounces	1,011	915	423	383
Stone	short tons	19,900	20,520	39,510	34,957
TOTAL VALUE		------	311,010	------	267,577
TULARE COUNTY					
Gold	troy ounces	------	------	26	910
Natural gas	thousand cubic feet	10,672,000	1,465,000	5,325,000	726,000
Sand and gravel	short tons	236,646	290,205	815,109	815,148
Silver	troy ounces	------	------	4	4
Tungsten concentrates (60% WO_3 basis)	short tons	139	197,025	60	(1)
Unapportioned: Clays, stone and minerals indicated by footnote 1		------	105,515	------	196,825
TOTAL VALUE		------	2,057,745	------	1,738,887
TUOLUMNE COUNTY					
Gold	troy ounces	1,314	45,990	372	13,020
Lead	pounds	------	------	200	32
Pumice	short tons	------	------	70	1,400
Silver	troy ounces	1,113	1,007	78	71
Stone	short tons	33,100	223,851	39,270	268,234
Unapportioned: Lime, sand and gravel, and slate (1949)		------	579,494	------	501,065
TOTAL VALUE		------	850,342	------	783,822

PRODUCT	1948		1949	
	QUANTITY	VALUE	QUANTITY	VALUE
VENTURA COUNTY				
Natural gas thousand cubic feet	46,023,000	$ 4,359,000	53,619,000	$ 5,806,000
Natural-gas liquids				
Natural gasoline gallons	*102,143,000	*7,595,000	96,977,000	7,405,000
Liquefied petroleum gases do	*34,974,000	*2,140,000	32,109,000	2,225,000
Petroleum barrels	*28,615,000	*71,727,000	34,032,000	80,860,000
Sand and gravel short tons	664,252	549,716	745,421	558,127
Unapportioned: Clays and stone	------	237,530	------	249,625
TOTAL VALUE	------	*86,608,246	------	97,103,752
YOLO COUNTY				
Sand and gravel short tons	195,050	84,673	412,375	165,226
Stone do	45,500	12,250	(1)	(1)
Unapportioned: Clays (1949), mercury (1948), natural gas, and minerals indicated by footnote 1	------	47,947	------	277,818
TOTAL VALUE	------	144,870	------	443,044
YUBA COUNTY				
1948: Gold, platinum-group metals, sand and gravel, silver.				
1949: Gold, platinum-group metals, sand and gravel, silver.				

1/ Value included with "Unapportioned." 2/ Natural gasoline and liquefied petroleum gases processed in Kettleman Hills oil field came from gas produced in both Kings and Fresno Counties. Such production is here assigned entirely to Kings County because figures by county are not available. 3/ Natural gasoline and liquefied petroleum gases in Santa Barbara County include a small amount from Russell Ranch Field, which is in Santa Barbara and San Luis Obispo Counties. a/ Not included in 1948 published figures. */ Revised figures.

COUNTY SUMMARIES

Alameda County

An all-time high in the value of mineral commodities produced in 1949 placed Alameda County in twelfth position among the 58 counties of the state. Sand and gravel for concrete aggregate, produced in the Livermore Valley and the Niles alluvial cone, constituted the largest single item of mineral production. Crushed stone for concrete aggregate, road surfacing, and fill material was also produced in large quantities. The quantity and value of salt produced by solar evaporation of sea water at Newark, were the highest on record. Magnesium compounds were produced in large quantities from salt plant bitterns. A small quantity of naturally bonded molding sand was mined in the Tesla area. Bromine and raw clay were produced at Newark and Niles, respectively.

Nonmetallic Industrial Materials. A typical sand-gravel operation was the new plant No. 104 of the Pacific Coast Aggregates Company. This modern plant located north of the Arroyo Valle Creek bed near Eliot in the Livermore Valley was opened in January 1949. The crude gravel was mined from a bowl-shaped pit about 400 feet in diameter at the surface. The excavation work was done by three 20-ton capacity Wooldridge terracobras, powered by 150-horsepower Cummings diesel engines. The extra digging-power required by the terracobra was supplied by a ''push'' from a Caterpillar D-8 diesel bulldozer. The terracobras began loading at the rim of the bowl, proceeded down the side toward the bottom, and discharged by bottom-dump to a grizzly located in the center, about 50 feet vertically below the rim of the bowl. The grizzly, about 12 by 20 feet with 10-inch openings, consisted of 90-pound inverted steel rails set in concrete. It was the starting point for the flow of gravel through the plant. The plant consisted of four units: a scrubbing unit, which feeds on crude pit-gravel and delivers a series of washed products to the stock piles; a crushed rock unit, which feeds on oversize gravel from the scrubbing unit and delivers a series of crushed products to the stock piles; a transfer station; and a screening-blending unit, which draws on the stock piles and delivers specification products for shipment and bulk storage. Recently facilities for grinding pea gravel to ⅜-inch size for the production of sand were placed in operation. The method is similar to the one employed at plant No. 118 of the same company. A return tunnel conveyor delivered gravel from the ⅜-inch stock pile to an 8- by 12-foot Marcy rod mill. The rod mill was designed for wet grinding with feeds at both ends and a central discharge to a set of screens. At the peak load, 51 tons per hour, 16 percent of the mill product was rejected by a ¼-inch screen. A net production of 43 tons per hour of minus ¼-inch sand was thus obtained. Similar grinding facilities have recently been installed by the same company at their plant No. 106 in Centerville. The company has also installed four 100-ton steel bins for truck loading, and a ready-mix plant at Eliot. The rectangular storage unit consists of twenty 250-ton bunkers in two rows of 10 bunkers each. This unit was designed primarily for railroad-car loading, and spur tracks of the Southern Pacific Railroad flank the unit on either side. The bunkers were discharged by bottom dump gates to an underlying conveyor belt 664 feet long running the length of the building. The discharge gates were operated by a series of levers from a central control point.

In this way products were blended directly on the belt itself. The conveyor was inclined upward at the end of the bunkers, elevating and discharging its load to a cross conveyor for railroad car loading. Each car received a load of approximately 60 tons. The plant was electrically operated throughout and a connected load of 3,500 horsepower was required for its operation. Water was required at the rate of 2,500 gallons per minute. The water horizon was located at a depth of approximately 70 feet below the surface. A total of 45 men were employed at the plant on a stable year-round basis. Three crews worked on a 40-hour week. Two shifts of 8 hours each operated the scrubber unit of the plant from 6 a.m. until 10 p.m. The finishing mill or screening plant operated one shift only. F.F.D.

Alpine County

Mining was dormant in Alpine County during 1949. The few operations which contributed to the intermittent activity of recent years suspended work or remained idle because of adverse market and general economic conditions.

Nonmetallic Industrial Materials. Rehabilitation and maintenance work by the Siskon Mining Company at the Leviathan mine southeast of Markleeville was discontinued in 1948. The sulphur deposit, originally worked as a copper prospect, has been opened by 3500 feet of underground workings, including two adits and related lateral headings. This work plus data obtained from approximately 30 diamond drill holes indicate an ore body containing in excess of four million tons of ore ranging from 25 to 50 percent sulphur. Remoteness of the deposit from rail transportation and lack of an economic recovery process are principal factors for suspension of operations at this time.

The small demand for sand and gravel concrete aggregate materials in Alpine County is usually met by intermittent production from deposits in National Forests.

Metals. Alpine Mining Company disposed of a small amount of tungsten concentrates produced in 1948 from their mine 3 miles north of Carson Pass. Here scheelite occurs in contact metamorphic ore bodies (tactite) which have been developed and mined by a 285-foot adit, a 200-foot winze sunk from the adit level, and several levels, together totalling about 1000 feet. Approximately 10,000 tons of ore had been mined to mid-1948. The concentrating plant is located 35 miles by road from the mine or 9 miles southwest of Gardnerville, Nevada. Tungsten prices in 1949 did not warrant operation of the property.

L.A.N., Jr.

Amador County

Amador was one of the most active mining counties in the Mother Lode district. Eleven lode gold mines and 32 gold placers were in operation. This activity extended from the East Belt where eight small lode mines and two dragline dredges were in operation, to the Foothill Belt where several placer deposits were worked. The Ione district led all other areas of the state in output of fire clay and was the chief source of this material for the ceramic industry of the San Francisco Bay area. Lignite was mined near Ione from open cuts and processed for the recovery of montan wax. A plant at Plymouth combined copper-slag and basalt to manufacture mineral wool. Building stone, crushed stone, and sand and gravel for concrete aggregate and road construction were also produced.

Nonmetallic Industrial Materials. The largest part of the Ione fire clay production was shipped to plants of Gladding, McBean and Company in Pittsburg and Lincoln. This company also started production of low-silica laterite (a type of rock formed by intense tropical weathering and composed of oxides of aluminum, silica, and iron) from an extensive deposit west of Ione. The deposit was discovered and explored early in 1949.

Western Refractories Company operated the only ceramic plant in the county. This plant, one mile southwest of Ione, manufactured firebrick and refractory shapes, and processed clay for sale on the open market. The plant was supplied from five fire clay pits and a gravel pit from which nearly pure quartz-gravel or grog was produced. Western Refractories Company allowed their lease on the Solari pit to expire at the end of December and began production of Ione sand from the Farci pit on January 1, 1950.

The Dosch pit about 2 miles west of Ione was worked by N. Clark and Sons Division, Pacific Clay Products Company. It furnished fire clay for the company's plant in Alameda, as well as small quantities to ceramic plants elsewhere. It has been worked continuously for a longer period than any other clay pit in California. The Calaveras Cement Company prospected for a very low-iron clay to be used in the production of white portland cement. A suitable deposit was acquired northeast of the town of Buena Vista and is now called the Kaolin pit.

Lignite produced near Ione was trucked to a pilot plant near Buena Vista which was operated by American Lignite Products Company Division, De Angelis Coal Company. This plant was the only domestic producer of montan wax, other sources being Germany and Czechoslovakia. The montan was extracted by the use of solvents. Lignite was first ground to minus 100 mesh, then passed through an extractor where the solvents removed various waxes, esters, resins, and asphalts. The solution was filtered, and the solute passed through a multistage counter-current separation system which removed the montan in solution. Steam distillation drove off the solvent leaving the wax in its commercial form. The sludge from the filtering operation was mixed with a fertilizer and marketed for agricultural use. Other by-products were sap brown, a paper dye, and Van Dyke brown, a paint pigment. A serious fire at the Buena Vista plant curtailed production for a short time during the late fall but the plant was redesigned and rebuilt with increased capacity. The present production is over 1,000,000 pounds of wax a year.

Mineral wool has been manufactured for the last few years by the Plymouth Rock Wool Manufacturing Company. Copper slag and basalt were used as raw materials. Slag from the Copper Hill mine west of Plymouth, which supplied the operation for several years, was exhausted prior to 1949 and has been replaced by slag obtained from Copperopolis in Calaveras County. Basalt came from Oroville Table Mountain in Butte County. At the mineral wool plant basalt and slag in a ratio of 1:4 were melted with coke in a blast-furnace. Liquid that collected at the bottom of the furnace flowed from three small holes into jets of high-pressure steam which blew the molten rock into long flexible threads of glass. Glass beads were removed from the mass of glass thread and the cleaned thread was bagged as commercial mineral wool. The mineral wool was used to insulate buildings and the by-product beads were sold for blasting sand.

Sand and gravel for use as road and concrete aggregates were produced near Jackson and Sutter Creek. Broken granite from the dump of the West Point tunnel at the West Point powerhouse was crushed in a portable plant operated by A. R. Milton. The Milton gravel plant supplied a large part of the road metal used in that vicinity by the counties of Amador and Calaveras. Small quantities of both red and white building stone were produced from the old Ione sandstone quarries on the east side of Buena Vista Buttes. It was used largely for garden stone and for the construction of fireplaces. A small amount of red and green marble was quarried at Waites Corner, west of Plymouth. It was hauled to the Sonora Marble Aggregate Company plant in Tuolumne County where it was crushed and marketed as terrazzo chips.

Metals. The Old Eureka mine at Sutter Creek was the largest active gold mine on the Mother Lode during 1949. Most of the ore was produced from workings below the 3400 level. Flotation concentrates were shipped to a smelter for treatment during the first quarter of the year, but in April a new cyaniding plant was completed where concentrates were subsequently treated. During 1948 the management of the Old Eureka started to fill square-set stopes with tailing sand. Sand fill continued to be used through 1949 and was found to be cheaper and to give better support than waste-rock fill.

At the Kennedy tailings dump near Jackson, using concentrating tables and flotation cells, F. J. Fuller recovered free gold, amalgam, and sulfides. The Black Hills mine in Drytown was operated for a few days in September. The dump of the old Pacific mine in Plymouth was worked for gold and sulfide concentrate by Ed Bloyed; a small pilot plant was used. During the same period the S. and R. Mining Company thoroughly sampled the Pacific mine dump in preparation for large scale mining activity in 1950.

Three dragline dredges were active in the Mother Lode district during the year. The Alpine Gravel Plant operated a dredge on its property along the North Fork of Jackson Creek during January and February: the Lilly dredge operated on the Cosumnes River for two weeks in January; and the McDonald dredge worked on part of Dry Creek during August.

The Belden, near Pine Grove, was one of the most productive lode mines in the East Belt. Extensive exploratory work was done at the Southern View mine, about 2½ miles east of Pioneer, where three new adits were driven. Development work was done at the Pidgeon drift mine at Fiddletown. Two dragline dredges operated in the East Belt in 1949. One, which operated on Pioneer and Sutter Creeks, was a non-float type; the other, on the Ludekins property near Pine Grove, was a floating dredge. The Union Flat hydraulic mine, 1 mile northwest of Volcano, was in operation from March through May. It was one of the two active hydraulic mines in the county. The largest placer operations in the Foothill Belt were the Stock dragline dredge on the Arroyo Seco Ranch near Ione, and the Kieth hydraulic pit in the Camanche district.

M.D.T.

Butte County

Gold dredging along the Feather River constituted the principal mining activity in Butte County. A small amount of gold came from a drift mine in Morris Ravine, and a number of the old drift mines in the Magalia and De Sabla districts were reopened for prospecting. The Magalia district produced a small tonnage of chromite. Sand and gravel and crushed stone, obtained largely from gold dredge tailings, ranked next to gold in value of mineral production. These nonmetallic products were used for concrete aggregate, rock fill, plaster sand, and in road construction.

Nonmetallic Industrial Materials. The Butte Creek Rock Company obtained old dredge tailings from a point on Butte Creek about 3 miles southeast of Chico. A Northwest dragline equipped with a 1¼-cubic yard bucket loaded the tailings into dump trucks for the short haul to the crushing and screening plant. Capacity of the plant was 600 cubic yards of washed and screened sand and gravel in 8 hours, and an adjoining hot asphalt plant had a capacity of 1000 tons in 8 hours. Thirty men were normally employed.

The Central Sand and Gravel Company, on Dry Creek about 14 miles southeast of Chico, mined hydraulic tailings that originated from the old Cherokee mine. A dragline excavated quartz sand and gravel from a long trench in the bed of the creek. Washed and screened sand and gravel were produced in a plant close to the trench.

The Feather River Rock Products Company employed a highline equipped with a ⅓-cubic yard bucket to mine old dredge tailings from the west bank of the Feather River about 4 miles east of Biggs. Capacity was 30 cubic yards per hour.

The Henry J. Kaiser Company produced crushed and screened rock from a dredge tailings pile about 8 miles south of Oroville. About 70 percent of the output was 2½- to ¾-inch rock used for railroad ballast.

J. J. Kennedy worked dredge tailings on the west bank of Butte Creek about 10 miles east of Chico. The tailings sand, which was not covered with gravel at this location, contained enough clay to make a good road patching mixture. The material was mined with a bulldozer.

The Mathews Sand, Gravel, and Dirt Company operated a gravel pit on the south bank of the Feather River about 3 miles east of Gridley. A dragline equipped with a ⅝-cubic yard bucket loaded the material into trucks for transport to an integrated screening and concrete mixing plant 1½ miles away. The plant, which employed six men, had a capacity of 60 cubic yards of concrete and 150 cubic yards of road metal in 8 hours.

The Pentz pit, on Dry Creek 12 miles north of Oroville, mined pit run sand and gravel. A D-6 Caterpillar bulldozer loaded the pit run material into trucks by means of a loading ramp. In a screening plant on the property minus 32-mesh material flowed through 120 feet of sluice boxes fitted with expanded metal laid on burlap to recover free gold. The plus 32-mesh material was washed, dewatered, and stored in stock piles above a concrete truck-loading tunnel. Products were washed plaster sand and concrete aggregate.

Metals. Chromite mining was resumed at the Lambert mine in the Magalia district in 1949. A new adit, 70 feet south of and 20 feet lower than the portal of the old adit, was driven 130 feet eastward through serpentine and struck a new ore body which has not yet been developed.

The Gold Hill Dredging Company operated the Kister dredge on the east bank of the Feather River about 5 miles east of Biggs. This dredge, which had a bucket line containing seventy-two 9-cubic foot buckets, dug an average of 8,000 cubic yards of gravel a day from depths of from 24 to 40 feet. The gold was recovered with a combination of jigs and sluices.

The Lancha Plana Gold Dredging Company operated a bucketline dredge on Butte Creek about 6 miles east of Chico until the middle of April. About 15 feet of gravel containing many 18- to 20-inch and occasional 36-inch boulders overlay a hard tuff bedrock. The dredge was equipped with a bucketline with fifty-seven 4½-cubic foot buckets driven by a 50 horsepower motor. The gold was caught in sluice boxes fitted with rubber-covered wooden riffles.

Yuba Consolidated Gold Fields operated two bucketline dredges on the Feather River about 5 miles east of Biggs where an 18- to 55-foot thickness of gravel free of large boulders lay on soft volcanic ash bedrock. The gravel was covered by 12 to 15 feet of top-soil. Both dredges had bucketlines with eighty-four 7½-cubic foot buckets and recovered the gold with a series of double decked sluices fitted with Hungarian riffles. Mercury traps were used in the first sluices. In November a third dredge, Biggs No. 4, resumed operations on Butte Creek about 3 miles southeast of Chico. It used a bucketline with sixty-seven 7½-cubic foot buckets. The three Yuba dredges operated 24 hours a day and employed crews of from 12 to 18 men each.

Morris Ravine Mining Company took over the driving of their development adit from the Split Rock Mines organization in January 1949. The cross section of the adit was reduced from 8 by 10 feet to 5 by 7 feet, new supporting timbers were placed where needed, and the track was re-aligned and graded. The adit was being extended through hard, fine-grained greenstone that required no timbering. A small quantity of gold was produced during the year from gravel taken from part of an old channel encountered by the development adit. The mill flow sheet was changed to a simple trommel screening and washing operation. The plus ½-inch gravel from the trommel was trammed to the dump in mine cars. Minus ½-inch material flowed through steel sluice boxes fitted with Hungarian riffles to catch the gold.

Several of the old drift mines were reopened and employed from two to five men each in retimbering adits or driving prospect adits or raises. Among these were the Channel (Dalley), Genii, Kelly Hill, and Red Mill mines in the Magalia district and the Royal (Best) and Shawnee drift mines on Butte Creek in the De Sabla district.

J.C.O'B.

Calaveras County

The mining of slate and limestone for use in the manufacture of cement at Kentucky House was the largest mineral operation in the county as well as in the entire Mother Lode district. Ione fire clay was mined from two open pits near Valley Springs. Colored rhyolite tuff was quarried at numerous points throughout the county and yellow marble was quarried near Vallecito. Copper slag was crushed and sold for the manufacture of mineral wool and as blasting sand. Gravel aggregate and garnet crystals were also mined. The East Belt was the most active gold mining district in the county. A few placer operations were active in the Mother Lode district. Copper and zinc concentrates (with gold, silver, and lead as by-products) were made at a mine in the Foothill Belt.

Nonmetallic Industrial Materials. The Calaveras Cement Company plant, located near San Andreas, operated throughout the year using crystalline limestone and associated metamorphic rocks as the principal raw materials. The cement rock was mined during 1949 at the No. 4 quarry located about 5 miles east of the plant. Broken stone was brought to the plant by truck over a paved private road. The Calaveras plant made cement by the wet process in which the ground raw materials are made into a slurry before calcining takes place. The plant flow sheet was similar to other California wet-process plants.

Important changes to the plant during 1949 were the installation of a Cottrell precipitator to remove dust from kiln gases and decompartmentation of certain of the kilns to allow greater daily kiln capacity. The capacity was rated at 2700 barrels of cement per day.

Two clay pits were active in Calaveras County, both near Valley Springs. One pit, on the northeast edge of the town, has been operated for more than 30 years by the California Pottery Company of Niles. Fire clay from the Ione formation was mined and trucked to the company's plant at Niles. There it was mixed with local clay and used in the manufacture of sewer pipe, chimney pipe, and drain tile. The second pit, about 3 miles northeast of Valley Springs, was opened in September by the Pacific Clay Products Company. Ione fire clay was mined and trucked to the company's plants in Stockton and Alameda. It was used largely for the manufacture of sewer pipe.

Rhyolite tuff was quarried near Murphys, Altaville, and Mokelumne Hill. E. Dillon mined white rhyolite building stone from a quarry on the property of F. A. Kenney, 2 miles southeast of Murphys, and from a quarry on the property of Al Gianelli, at Douglas Flat. Mr. Dillon used most of the stone for construction jobs. Aggregate was made from rhyolite tuff at the Palermo quarry, a mile northeast of Altaville.

Lavender and pink rhyolite tuff were mined from the Irvine quarry, about 3 miles south of Mokelumne Hill. Stone from this locality was used extensively in Calaveras County for construction work; especially for fireplaces, facing, and garden walls. In addition, small quantities were shipped to Sonora to be crushed and marketed as terrazzo chips.

Yellow marble was quarried east of Vallecito and hauled to the Sonora Marble Aggregate Company in Tuolumne County, where it was crushed and marketed as terrazzo chips.

At Copperopolis, copper slag from the old Copperopolis smelter was crushed and sold by John Johnson. The slag passed through primary and secondary crushers in closed circuit with a bank of screens. About 10 standard sizes of crushed slag, ranging from 6 mesh to minus 40 mesh, were produced and sold for use as blasting sand. Coarse slag was sold to the Plymouth Rock Wool Manufacturing Company, Amador County, where it was used in the manufacture of mineral wool. By-product beads from the mineral wool plant were purchased by Johnson, screened to size, and marketed as blasting sand.

The Neilsen Sand and Gravel Company mined and processed stream gravel in Chili Gulch, about 3 miles south of Mokelumne Hill. Stream-bed material was washed, graded to size, and sold for concrete aggregate.

The Garnet Hill mine, at the junction of Moore Creek and the North Fork of the Mokelumne River, was worked by A. K. Wolfsen for a short time during the spring. Wolfsen mined garnet crystals for sale to mineral collectors.

Metals. The Blackstone mine near West Point, operated by the Sanchez brothers, was in production for the entire year. The mine is on a quartz vein which strikes north and dips 45° west. The vein is cut by a system of basic dikes, striking east. Faulting has occurred along the planes of the dikes and the vein, and both are offset at some of the intersections. The largest bodies of ore occur along the intersections of the vein and the dikes and contain free gold, pyrite, sphalerite, and galena. The free gold and sulfide minerals were recovered on a concentrating table. The tailings were reground and the contained sulfides were removed by flotation.

The Centennial mine, near West Point, was worked by the New Champion Mining Company. The quartz vein strikes north. The ore consists of schistose dike rock with associated vein quartz, containing free gold and gold-bearing sulfide minerals.

A shallow prospect shaft was sunk at the Smith mine, half a mile southwest of Murphys. The ore was shipped directly to a smelter.

Placer operations along the Mother Lode included: a non-float dredge near Murphys, and the Slab Ranch drift mine at Altaville. No production was reported from the Calaveras Central drift mine at Altaville, but a new steel headframe was constructed and the shaft was cleaned out.

Two gold mines, the Donner and the Royal, were operating west of the Mother Lode. A mill at the Donner mine was completed during 1949, and the mine and mill operated for a short time at the end of the year. Gold and gold-bearing sulfides were recovered from the ore by amalgamation and flotation. The Royal mine, at Hodson, was operated from July to November. At the beginning of 1949 the mine consisted of a 36-foot vertical shaft, but during the year a total of 150 feet of drifts were driven. The ore was crushed in a 10-stamp mill. Amalgamation and flotation equipment were used to recover the gold and concentrate.

Placer mining in the west belt was limited to a few small-scale operations and to one dragline dredge. The dredge was operated by M. C. Jackson on the Stanislaus River near O'Byrnes Ferry.

The Penn mine in the Foothill Belt north of Campo Seco was worked by the Penn Chemical Company from May through October. The mine was worked through the No. 3 shaft which has a total depth of 3,200 feet. Ore was drawn from a shrinkage stope on the 500-foot level. The mill was entirely rebuilt in 1949 and was equipped with two flotation circuits in series. The first circuit removed a copper concentrate, which was shipped to Utah for smelting; and the second circuit removed a zinc concentrate, which was shipped to Texas. In addition to copper and zinc, significant quantities of gold, silver, and lead were recovered.

M.D.T.

Colusa County

Mining activity during 1949 consisted of sand and gravel production for concrete aggregate and road construction. The two producing areas were the west bank of the Sacramento River near Princeton, and a pit east of Sand Creek road about 4 miles south of Williams.

Nonmetallic Industrial Materials. Paul Entremont operated a sand and gravel pit on the Wolfram ranch south of Princeton. The material, dug to a depth of 12 feet below water level with a P & H dragline equipped with a $\frac{3}{8}$-cubic-yard bucket, was loaded into trucks for delivery. Jean Godon operated a pit on the Indian Reservation south of Princeton using a Scoopmobile loader fitted with a $\frac{1}{2}$-cubic-yard bucket. Goforth Brothers of Williams operated a concrete batching plant, and dug gravel from Cortina Creek 4 miles south of town. The creek channel was straightened to lessen erosion and the sand-gravel was dug about 2 feet deep with a Hanson dragline equipped with a $\frac{3}{8}$-cubic-yard bucket. The material is a sandy gravel with sub-angular pebbles of white quartz, red-brown jasper, and gray sandstone. Few pebbles are over 2 inches in size. The plant capacity was 100 cubic yards of concrete in 8 hours. McKesson Brothers operated a sand and gravel pit on the west bank of the Sacramento River at Princeton. The gravel was dug to a depth of 10 feet with a Ford tractor equipped with a $\frac{1}{2}$-cubic-yard bucket loader. Phil Shaver of Princeton operated a gravel pit a few miles south of Princeton at intervals during the year. The sand and gravel was loaded into trucks with a Scoopmobile and a Caterpillar tractor equipped with a Push-loader. Ralph Munger of Williams and the Colusa County Road District loaded gravel from the Thomas pit 4 miles south of Williams. The gravel was dug from banks 9 feet high and loaded onto trucks with power shovels. It is a mixture of red soil and sub-angular pebbles of quartz, quartzite, sandstone, and red-brown jasper. Few pebbles measured more than 2 inches in size. J.C.O'B.

Contra Costa County

The demands of the building industry for construction materials in this area maintained their production at a substantial level. Clay for brick manufacture and crushed rock were produced in considerable quantities. Pumice for lightweight aggregate was mined in the foothills south of Pittsburg. Dune sand for asphalt plants was mined east of Antioch and a small production of clay-free molding sand was also made. Seven natural gas wells were on production. Two springs produced mineral water in commercial quantities. In addition, large quantities of mineral substances from outside sources were utilized in the industrial plants of the county.

Mineral Fuels. Considerable natural gas was produced in Contra Costa County from the Eocene sands that underlie the northeastern part of the county. The producing wells are in the south end of the Rio Vista gas field, which extends southward from Sacramento County. One wildcat well was drilled 4 miles northeast of Brentwood during 1949 by the Standard Oil Company. No production was obtained.

Nonmetallic Industrial Materials. The Henry J. Kaiser Company rock plant at Upton, south of the tunnel road 1 mile west of Orinda, quarried rock from volcanics of the Pliocene Moraga formation. The best material came from a flow of dense, tough basalt. The quarry face was approximately 75 feet high by 300 feet long. Toe-holes were drilled in the face of the quarry with wagon drills, and after blasting, the fragmented material was loaded onto trucks by a dipper-type 2½-yard Northwest shovel.

The Harrison-Birdwell quarry and rock plant, 1 mile south of Clayton, has been producing crushed stone for road fill and drain rock since July 1947. This operation employs seven men. Two pits have been opened in members of the Jurassic Franciscan formation, one in serpentine, and one in sandstone. The former pit was abandoned after a large area of soft rock was uncovered near its center, and operations were shifted to the latter pit located a quarter of a mile southward.

The Blake Brothers operation at Point Richmond on San Francisco Bay includes a quarry; a rock crushing, sizing, and distribution plant; a ready-mix concrete plant; and a hot asphalt plant. The quarry is in Franciscan sandstone. The coyote hole method was employed to shoot down as much as 500,000 tons of rock with a single blast. The adits were about 60 feet long, and the crosscuts were driven at right angles to the adits about 100 feet in both directions. After charges had been placed at 20-foot intervals, and the openings had been completely back-filled, all charges were electrically detonated simultaneously. Steam shovels loaded trucks which hauled the rock to the primary crusher located in the quarry. Trucks hauled the primary crusher product to the plant receiving bins, a distance of about an eighth of a mile. Several stages of crushing and screening in the plant produced nine rock sizes from a quarter inch to six inches. Riprap was also produced.

Serra Brothers operated a rock quarry and crushing plant a quarter mile south of Pacheco on the Pacheco-Walnut Creek road. The quarry was in moderately well-consolidated, light-brown sandstone, interbedded with some soft shale. These rocks are part of the Sobrante formation of Miocene age.

The Pittsburg Pumibloc Company mined pumice in the foothills south of Pittsburg for light-weight aggregate in concrete building blocks. The pumice was obtained from a bed of waterlaid pumiceous tuff interbedded with sandstone and conglomerate. The pumice was mined with a Caterpiller tractor and rooter and pushed to the crushing plant with a bulldozer. After crushing to minus three-eighths inch, the pumice was hauled to the block plant on the highway 3 miles west of Pittsburg. Here the pumice was mixed with cement and sand and pressed into blocks. The block-pressing machine has a capacity of 1000-1200 units per day. Blocks were oven-dried for 8 to 10 hours at 100° F., and then placed in the curing yard for 28 days. During the curing period they were sprinkled occasionally with water.

Two brick plants, the Port Costa Brick Works on Carquinez Straits (three-quarters of a mile east of Port Costa), and the United Materials and Richmond Brick Company at Point Richmond, manufactured bricks from clay mined in the county. At Port Costa brown and blue clay-shale mined near the plant was used and a large, coal-burning, continuously-fired Hoffman kiln was in operation. During summer months, the time of high demand, several gas-fired field kilns supplemented the production from the Hoffman kiln. At Richmond, bricks were produced from a mixture of black shale mined adjacent to the plant, and clay from Lincoln and Ione. Six oil-fired kilns were in operation.

Foundry sand was produced from beds of Eocene sandstone that outcrop south of Antioch and at Nortonville. Demand for this material was small in 1949, owing to the closing of the Columbia Steel Company foundry. Dune sand from east of Antioch was shipped to asphalt plants.

J.W.V.

Del Norte County

The principal mining activity in Del Norte County during 1949 was the quarrying of rock for a breakwater-jetty in Crescent City harbor. A small quantity of chromite was shipped from the Tyson mine at French Hill.

Nonmetallic Industrial Materials. Rock for the Crescent City harbor breakwater-jetty was quarried at Point St. George about 4 miles northwest of Crescent City. The contract called for an estimated 575,000 tons of rock to be quarried and placed by 1951. Sixty men were employed on a 10-hour shift each season between May 1 and October 15, when the sea was quiet. The rock, principally gray Franciscan sandstone, was blasted by the coyote-hole method. Bags of black powder were loaded into 60-foot crosscuts driven at right angles in both directions from the ends of coyote drifts $3\frac{1}{2}$ feet wide, 5 feet high, and 40 to 60 feet long. The rock broke well and powder consumption averaged three-quarters of a pound per ton of rock broken. The broken rock was sorted into three sizes; ''A'' stone weighing 7 to 20 tons, ''B'' stone weighing 3 to 7 tons, and ''C'' rock weighing 5 pounds to 3 tons. Power shovels loaded the rock into 15-ton Euclid dump trucks for the haul from the quarry to the jetty.

Metals. From the Tyson mine on French Hill a small amount of chromite was shipped during the year. A few small lenses of chromite in serpentine were exposed in the floor of the pit after the loose overburden was removed by hydraulic mining in 1948. The mine was idle in August 1949, although the equipment remained on the property.

J.C.O'B.

El Dorado County

Several of the largest mining operations in the county involved the mining and quarrying of high-calcium and high-magnesium limestone. Much of this limestone was burned to lime and the remainder was sold for industrial and agricultural uses. Slate was mined by underground methods at Chili Bar. Rhyolite and massive quartz were quarried at four localities and used in the construction industry. Eight lode mines produced a total of 1,071 ounces of gold, and 13 placer properties reported production of gold and silver. Sand and gravel, crushed rock, and talc were also produced.

Nonmetallic Industrial Materials. The Diamond Springs Lime Corporation at Diamond Springs produced crushed limestone, high-magnesium lime, and high-calcium lime. Dolomitic (high-magnesium) limestone was quarried 3 miles east of the plant, but high-calcium limestone was shipped in. Stone from the quarry was transported by tramline to the plant where it was reduced in size to minus $1\frac{3}{4}$ inches. Plus 1-inch material was burned to lime and all smaller sized material was used for road aggregate, concrete aggregate, white wash, and the manufacture of skeet targets. The lime was burned in two rotary kilns and passed through two rotary coolers. The company's high-calcium lime was used in steel-making, putty production, and water purification; and the dolomitic lime was used largely in construction and agriculture.

Lime and crushed industrial limestone were also produced by the Auburn Lime Products Company at Rattlesnake Bridge, 4 miles southwest of Pilot Hill. High-calcium limestone was quarried about a quarter of a mile north of the plant. Primary crushing was done at the quarry and secondary crushing and screening at the plant. The fragments over a quarter of an inch in diameter were fed into two 4- by 60-foot rotary kilns and were burned to lime. The lime passed through a rotary cooler and into loading bins for sacking or bulk loading. The minus one-quarter inch stone was screened into four sizes and marketed for various industrial uses.

The El Dorado Limestone Company, 3 miles southwest of Shingle Springs, mined high-calcium limestone by underground methods. Two lenses of Calaveras limestone, one 80 feet thick and the other 30 feet thick, were mined in shrinkage stopes, and the limestone was hoisted to the surface through a 750-foot vertical shaft. A large crushing plant at the head of the shaft reduced the stone to minus 1 inch, and separated it into several sizes. It was marketed for use as metallurgical flux, asphalt filler, roofing granules, and for the manufacture of lime, glass, and water paint.

Crushed high-calcium limestone was also produced by Cragco Products, Incorporated, from a large quarry 1½ miles north of Cool. Stone broken in the quarry was hauled a short distance to a crushing plant. Material over 2 inches in diameter was sold mostly for sugar rock, metallurgical flux, and for the manufacture of milk of magnesia. Minus 2-inch stone was sold largely for road material.

Crushed stone for road aggregate was produced intermittently by the county from a number of quarries. Sand and gravel was taken from a bar on Weber Creek, about 5 miles northwest of Placerville, by the El Dorado Rock and Sand Company.

Talc schist, with lenses of nearly pure talc, was mined by Pacific Minerals Company at Shrub, a siding on the Southern Pacific Railroad about 3 miles northeast of Latrobe. A mixture of unweathered rock and red clayey weathered rock was taken from an open pit and shipped to the San Francisco Bay area. Here it was ground and marketed for use as an insecticide filler and, to some extent, as a lubricant.

The Pacific Minerals Company also operated a large underground slate mine at Chili Bar, on the South Fork of the American River near Placerville. Black Mariposa slate was mined in long open stopes, 16 feet high and 20 feet wide, and trammed to a crushing and screening plant adjacent to the mine. The fines were passed through a rotary drier and the larger pieces were put through a hammer mill. The crushed slate was screened in closed circuit with a secondary hammer mill to produce two final products: roofing granules, minus 7 mesh to plus 16 mesh; and dust, minus 200 mesh. Saturating oil was added to the finished granules to facilitate binding to asphalt and to reduce the amount of dust given off during handling. The dust was used as inert filler in asphalt, paint, and linoleum.

T. C. Hunt quarried pink-colored rhyolite tuff, and white and yellow-colored rhyolite tuff from a deposit at Johnson's Mill, 2 miles south of Camino. The stone was used in the construction of fireplaces, walls, and buildings. Similar white and yellow-colored rhyolite tuff was quarried near Pleasant Valley by R. C. Young. During 1949 Mr. Young was conducting experiments (by firing the tuff in a stationary kiln) to change the colored bands in the stone from yellow to deep red. Massive quartz with green-colored mariposite was mined underground by Jack Fennamin from a small mine on the edge of Placerville. It was used for garden stone and in construction work.

Metals. The Shaw mine, 4 miles southwest of Placerville, was put into operation June 1 and was worked for the remainder of the year. The ore was in the margins of a highly weathered diorite dike, about 125 feet thick, which intruded Mariposa slate. The ore was mined in an open pit with a power shovel and hauled to a nearby mill. Free gold was recovered by amalgamation, and concentrates containing gold-bearing sulfides were shipped to a smelter.

Other producing mines were the Cosumnes mine near Grizzly Flats, the Gardner mine at Kelsey, the Hazel Creek mine south of Pollock Pines, the Spanish Dry Diggings mine at Spanish Dry Diggings, and the Summit Hill mine at Spanish Dry Diggings.

Gold and silver production was reported by: the Matherly suction dredge on the American River near Lotus, the Ernest Wilsey dragline dredge on Cherokee Bar, the River Pines dragline dredge on the Middle Fork of the Cosumnes River near Diamond Springs, the Twin Forks dragline dredge on the North Fork of the Cosumnes River near Youngs, and the dredges of Lord & Bishop on Carson and Greenwood Creeks.

M.D.T.

Fresno County

Its extensive petroleum and natural gas industry has placed Fresno third among the counties of the state in value of annual mineral production. The products of sand-gravel and crushed rock plants located along the channels of the San Joaquin and Kings Rivers were valued at more than 1 million dollars. Monumental stone was quarried at Academy. Gypsite for agricultural use was mined in the foothills along the western edge of the San Joaquin Valley. Suction gold dredges operated intermittently along the San Joaquin River near Friant. A small quantity of raw clay was also produced.

Mineral Fuels. Four discovery wells were drilled in Fresno County during 1949. The Pacific Western Oil Company's ''Waechter'' 12-X achieved production northwest of the productive wells of the San Joaquin area on March 1. Initial yield was 100 barrels per day of 31.4-degree gravity oil from a stratigraphic trap in Eocene sediments. The producing interval was 7019-7020 feet. L. M. Lockhart's ''Postal Union'' 2-35 had an initial production of 108 barrels per day from a stratigraphic trap in Miocene sediments in the interval 6550-6570 feet. This discovery, made March 22, established the northwesterly extension of the Burrell productive areas. In April 1949 a new productive zone was discovered at Guijarral Hills in the Miocene Temblor formation, 500 feet stratigraphically above the Leda zone (Oligocene), by Barnsdall Oil Company's ''Allison'' 73-34-2. Initial production was 250 barrels per day of 38.2-degree gravity oil. By the end of the year there were 56 completed wells in the field. On October 10, the northwesterly extension of the

Raisin City field was discovered by the well "K.R.D." 33-10 of the Northwest Syndicate and British American Oil Producing Company. Initial production was 167 barrels per day of 23.3-degree gravity oil from a stratigraphic trap in Miocene sediments in the interval 4990-5010 feet.

Most of the natural gas produced in Fresno County was wet gas from the oil fields that was piped to plants which extracted natural gasoline and liquefied petroleum gases. Plants engaged in this activity in the county yielded products valued at more than 3.5 million dollars annually. Reserves of natural gas in Fresno County were estimated to be in excess of 2,000,000,000 thousand cubic feet.[1]

Nonmetallic Industrial Materials. Thompson Materials and Construction Company supplied rock aggregate to the southwestern part of Fresno County and adjoining areas from their plant 6 miles northwest of Avenal. Gravel from terraces on the south side of Zapato Creek was processed at this plant to yield several sizes of crushed rock and washed sand. The plants of Stewart and Nuss, Anderson Rock Company, Pacific Coast Aggregates, and the River View Rock Company, were on the San Joaquin River between Highway 99 and Friant Dam. Central Rock and Sand Company operated an aggregate plant on Kings River, 2½ miles east of Sanger.

The Superior-Academy Granite Company produced "black granite" for monumental use 1 mile northeast of Academy; only one of the company's quarries was in operation. The stone, a dark-colored hornblende diorite, was removed in blocks weighing 10 to 12 tons and transported by truck to the finishing shop in Clovis. In recent years improvement in cutting and trimming methods at the plant has decreased rock waste.

The Marlife Company, formerly the Marlifertilizer Company, continued to maintain production of several hundred tons of marl per week from their deposit 4½ miles east of Mercy Hot Springs. Marl, used in the agricultural areas as a soil conditioner, was mined with a Caterpillar tractor and carry-all, which also stripped 3 feet of overburden. A hammer mill pulverized the marl. Al Feuerstein of Fresno produced limestone intermittently from the Red Bud limestone deposit, 4½ miles southeast of Tollhouse. The limestone was quarried by hand and passed through two crushers and a rod mill. The product was used for poultry and chick grit, mixed feeds, and soil treatment.

Gypsite, an impure variety of gypsum containing 40 to 80 percent $CaSO_4 \cdot 2H_2O$, was mined and marketed exclusively as agricultural material. Deposits of gypsite are numerous in the Coast Range foothills along the western edge of the San Joaquin Valley. In Fresno County these deposits have been mined in at least five places: three at the mouth of Tumey Gulch, 18 miles southwest of Mendota; and two near Mercy Hot Springs (one about 8 miles east and the other 3 miles north of the Springs). Carry-all scrapers were used to mine the gypsite at these deposits. Production was reported from two deposits during the year.

Part of the clay used at the Craycroft Brick Company plant in Fresno is obtained from a shallow deposit of hardpan on the property. Clay from other counties supplements this supply.

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[1] Bush, R. D., et al., California oil fields: California Div. Oil and Gas, Summary of Operations, vol. 34, no. 2, p. 33, 1948.

Metals. Suction gold dredges operated intermittently on the Fresno County side of the San Joaquin River. Several gravel plants operating along the San Joaquin River have installed riffles to recover gold from the gravel they process. In the period 1940-1942 gold valued at $196,977 was recovered from 4,457,320 tons of gravel mined from the San Joaquin River by the Bent and Griffith companies for use in Friant Dam. This gravel was obtained from a pit on the south bank of the San Joaquin River, 2½ miles downstream from Friant Dam.

J.W.V.

Glenn County

The production of sand and gravel for concrete aggregate, corrals, and road construction, constituted the principal mining activity in this county.

Nonmetallic Industrial Materials. Lester G. Madsen operated a gravel pit on the Dunlap ranch about 2 miles northeast of Willows. The gravel, which contained pebbles of quartz, quartzite, sandstone, and red-brown jasper, but with few cobbles more than 5 inches in diameter, was dug to a depth of 15 feet with a P. and H. dragline equipped with a one-half cubic yard bucket. About 6 feet of sandy soil containing enough clay to make a good binder for road metal lay above the gravel. W. C. Railing mined some gravel from the Parker pit, which adjoins the Madsen pit on the east.

D. T. McIntosh of Chico intermittently worked a gravel deposit on the north bank of Stoney Creek, 2 miles south of Hamilton City. An Insley dragline with a one-half cubic yard bucket dug the gravel to a depth of 6 feet. The Orland Sand and Gravel Company operated their plant on the north bank of Stoney Creek, just east of U. S. Highway 99W and half a mile north of Orland. Products were crushed and washed sand and gravel and ready-mixed concrete. A Bucyrus-Erie power shovel of 1¼-cubic yards capacity mined the gravel from 6 to 10 feet deep. During the year a 10- by 16-inch jaw crusher was added to the plant ahead of the 22- by 40-inch rolls.

R. P. Thuemler occasionally operated the Robert Millar pit on the west bank of the Sacramento River, east of Glenn. A Cletrac tractor with a Ware hydraulic loader attachment and a 10-cubic foot bucket was employed to mine a gravel bed 3 feet thick. Thuemler also obtained gravel from a pit 1 mile east of Willows and a quarter of a mile north of the Glenn road. The gravel, which was dug to a maximum depth of 20 feet with a three-quarters cubic yard Lima dragline, contained pebbles of quartz, quartzite, jasper, and fine-grained, gray volcanic rocks. Wruck Brothers and Davis obtained the sand and gravel for their Willows ready-mixed concrete plant from the Thomas pit, which is on the west bank of the Sacramento River, 2 miles north of Glenn. The gravel was dug to a depth of 10 feet with a Byers dragline equipped with a one-third cubic yard bucket and trucked the 15 miles to Willows.

J.C.O'B.

Humboldt County

The production of sand and gravel for use in concrete and for roads was the principal mining activity in Humboldt County during 1949. In addition, common brick and drain tile were manufactured from clay from Eureka Slough, and the Pearch hydraulic mine near Orleans produced gold.

Nonmetallic Industrial Materials. The Hindley Clay Products Company manufactured common red brick and drain tile from clay dug on their property on Eureka Slough, 1½ miles north of Eureka. Clay mined from a shallow pit with a bulldozer and dragline passed through a disintegrator and was mixed with water in a pug mill. An auger machine then fed it to a wire cutter, which produced twelve 2¼- by 4- by 8-inch bricks at a time. They were loaded on wooden palettes and dried for 30 days before being fired in a down-draft circular kiln. After a preliminary burning period of three days, during which the kiln was fired with wood, oil burners were turned on, and the bricks were burned for an additional 60 hours at a temperature of 1900° to 2000° F. Two men were employed on a daily shift.

The Eureka Sand and Gravel Company operated a gravel pit and screening plant in the James Creek district, 2 miles north of Arcata. A dragline with a one-half cubic-yard bucket was used to dig gravel from a bar on the south bank of Mad River. The bottom of the pit, which was 8 feet deep, was 6 feet below water level. An adjacent screening plant equipped with a double-decked shaking screen produced washed and sized material. Seven men were employed on a daily shift.

The Kelly and McWhorter Sand and Gravel Company operated a pit at Palmer Creek on the east bank of the Eel River, about a mile northwest of Fortuna. A pit 15-feet deep, whose bottom was 5 feet below water level was excavated with a one-half cubic yard dragline. Five cubic yard dump trucks hauled the gravel a quarter of a mile to the company's screening and transit-mix batching plants. The T. & H. Mortarless Tile Company's concrete block and tile plant used aggregate purchased from the Kelly and McWhorter Sand and Gravel Company.

The Mad River Sand and Gravel Company operated a gravel pit and screening plant on the south bank of Mad River, 6 miles north of Arcata and a quarter of a mile west of the State Highway. The gravel was dug with a dragline equipped with a five-eighth cubic yard bucket. Although most of the 1949 sales were of unscreened river-run material, some gravel was processed in the screening plant, which had a capacity of 800 cubic yards of standard sizes in 8 hours. This company furnished the aggregate used by the neighboring A. & E. Readimix Company, an operation that went into production in August.

The Mercer-Fraser Company operated plants at Essex, Orick, and Worswick during the year. The Essex plant was located on the north bank of the Mad River at Essex. Gravel from a bar on the south side of the river was dug with a three-quarters cubic yard dragline and hauled about a quarter of a mile to the plant. Here is was either crushed to minus 1½-inch with an Austin-Western portable crushing and screening plant of 800 cubic yards capacity in 8 hours, or washed and screened in a permanent wooden frame plant of 500 cubic yards capacity in 8 hours that produced washed material of desired sizes. A Madsen hot oil plant with a capacity of 800 tons of road-mix in 8 hours was operated at the Essex site. Minus 1-inch gravel that had passed through a rotary drier was separated on a double-decked vibrating screen into four sizes, which were stored in separate bins. Batches of the specified quantities of materials were heated to from 250° to 325° F. and mixed with from 87 to 107 pounds of oil per ton of rock. The screening plant, concrete batch mixing plant, and asphalt mixing plant at Orick were supplied with gravel from

Redwood Creek at the mouth of Prairie Creek, about 2 miles northeast of Orick. Sand and gravel were dug to water level at a depth of 5 feet. The gravel, which consisted of white quartz, quartzite, conglomerate, and gray trap rock, contained no boulders and few cobbles greater than 3 inches in diameter. The Worswick plant was located on the east bank of the Eel river at Worswick Siding. The slackline excavator used to excavate the gravel was operated with a double drum hoist that received power from a Caterpillar D-13,000 diesel engine. The plant, which was equipped to load both railroad cars and trucks, had a capacity of 150 cubic yards of screened material or 300 cubic yards of river-run material in 8 hours.

Other producers of sand and gravel included the Arcata Sand and Gravel Company on the Mad River, just east of U. S. Highway 101; Butler and Dye of Eureka, who worked various pits on the Mad and Eel rivers; A. Capwell of Eureka; and Rhodes and Manley of Eureka. Many producers worked intermittently, and most of their product was river-run material used for logging roads.

Metals. The Pearch hydraulic mine, on the east bank of the Klamath River, about 1 mile north of Orleans, was operated by C. L. Crowder and associates for the first half of the year. In October the property was sub-leased to Luthena White and Fred Ray, who repaired the ditches, flumes, and pipe lines to gain additional water. Gold occurs in 10 to 15 feet of gravel which rests on slate and schist bedrock. Overlying the pay gravel was 10 to 15 feet of sand and 50 to 70 feet of overburden and soil. Boulders and cobbles were numerous. Water, obtained from Pearch and Cheney Creeks through 1½ miles of ditch and flume, was delivered through 1500 feet of 48 to 16-inch steel pipe to the giants at a 175-foot head. After the bank was broken down with water from a hydraulic giant fitted with a 5-inch nozzle, the gravel passed through 1500 feet of 32- by 36-inch sluice boxes that had wooden-block riffles 10 inches in diameter to catch the gold.

J.C.O'B.

Imperial County

Mining gypsum by open-pit methods and processing the crude material at Plaster City was the most important operation in this county. ''Mica schist'' was produced and processed at a deposit near Ogilby, and was used as a backing for roofing paper. Pumice for lightweight building blocks was produced in substantial quantities at the southeastern edge of the Salton Sea. Carbon dioxide gas wells at Niland have been productive for many years. The rebuilding of the Holmestake Mining Company's cyanide plant at Winterhaven should stimulate activity in gold mining. Sand and gravel was also produced.

Mineral Fuels. No petroleum deposits have been found in Imperial County to date. Formations favorable to the formation of petroleum are not in evidence, although there are structures in the Carrizo formation, which could form traps.

Some drilling has been done in Imperial County over a period of years, with no results except slight gas showings in some of the wells.

In 1949 no wells were drilled in Imperial County.

Nonmetallic Industrial Materials. The Western Nonmetallic Company produced about 5,000 tons of their product ''Mica Schist,'' which was used exclusively for backing on roofing papers. The company operated three quarries and a processing plant approximately 4 miles northeast of Ogilby. From 150 to 200 tons of ore, constituting about a week's supply, were blasted at one time. Processing to produce a finished product size averaging 55 percent minus 200-mesh, included grinding, screening, and air classifying.

The Superlite Corporation operated pumice deposits at Pumice Butte, and pumice block plants at Calipatria, Phoenix, Arizona, and Albuquerque, New Mexico. The Calipatria plant produced its first blocks during 1949. At the deposit 8 miles northwest of Calipatria, two 16-cubic yard carryalls pulled by D-8 Caterpillars mined pumice from open pits and discharged it into grizzlys. Blasting was not required. The pumice was crushed and screened to the following sizes: three-eighths to one-quarter-inch, one-quarter to one-eighth-inch, and minus one-eighth-inch. About 20 percent of the crushed pumice was too fine for use in making blocks. Production of about four 50-ton cars a day has since been increased to nine cars a day, and a second shift has been added.

The United States Gypsum Company's plant at Plaster City produced at peak capacity except for a temporary curtailment in the early part of the year, caused by a slackening in demand for building materials. Gypsum quarried from a large deposit at the north end of the Fish Creek Mountains was shipped over a private railroad 26 miles long to Plaster City for processing. In the spring of 1948 the company completed a program of modernization and expansion, which included the construction of numerous large buildings at Plaster City.

Cardox Western, Inc., produced carbon dioxide from its wells in the Salton Sea field. Most of the gas was used in the production of dry ice, but a small quantity was marketed as liquid carbon dioxide. The average depth of the wells is about 635 feet and their productive life is about 2 years.

Several sand and gravel operations were active in the county. Unique among these was the operation of J. B. Nelson near Holtville. Very carefully sized gravel was produced here and sacked for shipment to the company's plant at Long Beach. The gravel was used entirely for oil-well packing.

Metals. The Holmestake Mining Company spent the year prosecuting a law suit, which resulted from the destruction by fire of their mill at Winterhaven in March 1947. The company was awarded a settlement and construction of a new mill was started in February 1950. The new mill is all concrete and steel construction and is once again (August 1950) cyaniding the ores from the company's two properties, the Cargo Muchacho and the Padre and Madre mines. A jig has recently been introduced into the mill circuit to recover a small but as yet undetermined amount of scheelite that occurs in the ores.

J.W.C.

Inyo County

Metal mining activities were centered principally on lead-silver-zinc ores in the Darwin, northern Argus Range, and Tecopa areas and on tungsten ores in the Bishop area. These metals accounted for a major portion of the county's total mineral production. Talc, produced from several areas in the Inyo Range talc belt and from Warm Spring Canyon, and soda products from Owens Lake were the most important of the several nonmetallic industrial materials produced.

Nonmetallic Industrial Materials. Fuller's earth was mined by the Sierra Talc and Clay Company from the Calearth deposit near Olancha. A room-and-pillar mining method was used, utilizing pneumatic spaders, or ''clay diggers'', instead of the conventional drilling and blasting equipment. The clay is used principally in the decolorizing and deodorizing of various oils and solutions.

Dolomite was produced by Dolomite Products, Incorporated, operating the Inyo Marble Company deposits north of Keeler. The dolomite was quarried from open cuts and hauled a short distance by truck to the crushing and screening plant at Dolomite, a siding on the Keeler branch of the Southern Pacific Railroad. Roofing granules and terrazzo chips were produced; lesser amounts were sold for plaster sand and poultry grit. Production was at a rate of 300 to 400 tons per month.

The West End Chemical Company produced limestone from a deposit located 13 miles north of Trona. The limestone was hauled to West End on Searles Lake, San Bernardino County, and calcined there to furnish carbon dioxide for use in the carbonation plant.

A relatively small tonnage of perlite was produced from the Fish Springs area south of Big Pine. Pumice was produced from several properties between the Haiwee Reservoir and Little Lake. The largest operation was that of the Desert Materials Company which operated an open pit located about 8 miles northeast of Coso Junction. The pumice was hauled by truck to the screening plant at Sykes siding. This plant has a capacity of from 45 to 115 yards per hour depending upon the size being produced.

Mr. H. A. Van Loon operated a pumice deposit north of Bishop, producing pumice fines which were hauled to Bishop and mixed with coarser material for making slabs or building blocks. Red volcanic cinders were being mined for aggregate material from Red Cinder Mountain north of Little Lake.

The Talc City mine, operated by the Sierra Talc and Clay Company, was the largest of several talc producers in the county. The property also provided most of the domestic output of steatite-grade talc. The principal talc body in this mine has a 70° westerly dip and has been mined to an inclined depth of 415 feet. The White Mountain mine, northeast of Keeler on the southeastern slope of the Inyo Range, is also an important producer of steatite-grade talc. William Bonham operated this and other properties in the same area. Talc from the Talc City and White Mountain mine areas was hauled to the Sierra Talc and Clay Company mill at Keeler for grinding and sizing. Blue Star Mines, Limited, operated their custom talc grinding plant at Zurich. Some talc was shipped here from properties on the west side of Saline Valley. The Warm Spring Canyon talc deposits were operated by the Kennedy Minerals Company and Miss Louise Grantham.

Soda products and borax were produced by the Columbia Chemical Division of the Pittsburg Plate Glass Company in their plant on Owens Lake.

Metals. The Trail Canyon road was rebuilt to the Old Dependable Antimony mine in the Panamint Range and some development work was done, but no ore was shipped. Gold was produced with the lead-silver-zinc ores at the mines operated by the Anaconda Copper Mining Company at Darwin and Tecopa. There was some activity at the Arando mine in the Argus Range, the Corona and Skidoo mines in the Panamint Range, and the Stockwell mine in the Slate Range, but no gold production was reported.

The Anaconda Copper Mining Company continued its operations at Darwin and Tecopa and was the principal producer of lead, silver, and zinc in the state. The prices of lead and zinc dropped sharply in the second quarter of the year, and because of this, the operations at the Darwin mines were suspended from July to September, 1949. Only necessary maintenance and a small amount of development work was undertaken during this period. During the rest of the year, however, normal mining operations progressed. The average grade of ore milled in the 300-ton mill was approximately 7.5 percent lead, 7.5 percent zinc, and 5 ounces of silver per ton.

The Shoshone mines operation near Tecopa continued through the year, and the company developed substantial additional tonnages of both direct-shipping and milling grade lead-silver ore. The 100-ton mill, which had shut down in September 1948, resumed operations in July 1949, after the discovery of ore in the faulted segment of the War Eagle vein on the 500 level. This ore proved to be continuous to the 690 level. Over 12,000 tons of mill ore and nearly 13,000 tons of shipping-grade ore was produced during the year.

The Defense mine in the Argus Range was operated by L. D. Foreman and W. V. Skinner. The principal ore mineral here is coronadite, an oxide of lead and manganese. New development work included the start of a haulage adit located 150 feet below the main entry. At the Minnietta mine in the same district, a small mill was in operation treating old mill tailings. The concentrate from this mill was shipped with ore from the mine. Other producers in the area included the Surprise and the Empress mines.

The Cerro Gordo mine near Keeler which had been leased by the Enterprise Mining Corporation, was purchased by them in 1949. Development and exploration work was continued in the China Stope area between the 200 and 550 levels. Several cars of ore were shipped from the Lippincott lead mine in the Ubehebe district to the Lippincott Lead Company smelter at Santa Ana. The Gold Hill Dredging Company commenced development work on the Kerdell lead mine in the Panamint Range; the Christmas Gift mine in the Darwin district was being reopened by Christmas Gift Mines, Incorporated.

The United States Vanadium Corporation operating the Pine Creek tungsten mine continued development work from the new Zero tunnel level. This tunnel, started in 1943 and completed in December 1947, is 7400 feet long and 1500 feet below the upper main haulage level. Two ore bodies were being developed for a sub-level stoping method of mining. Surface installations, which were completed during 1949, include a rotary tipple for dumping the mine cars into a coarse ore bin, a 36 by 48-inch jaw crusher and a 1000-ton live storage bin. Crushed ore is fed from this bin by apron feeders into buckets on an aerial tram which transports the ore to the 1200-ton mill on Pine Creek. In February 1949, a fire destroyed the tram terminal and crusher installations at the upper main haulage level, so all ore from there was hauled by truck to the Zero level installations during the balance of the year. Molybdenum and copper concentrates, the latter carrying some silver and gold, were produced in addition to tungsten.

The Kittle Mining and Exploration Company operated the Round Valley mine in the Tungsten Hills west of Bishop. Ore was produced from a winze sunk off the west end of the inclined-shaft level and was milled at the El Diablo mill. The grade of ore, on the basis of mill recovery, averaged 0.7 percent WO_3. The Tungstar Corporation rehabilitated their mill on Pine Creek and milled about 1000 tons of ore from the Black Rock mine in Mono County. Ferberite concentrates were produced from the Yaney mine located 4½ miles southwest of Bishop.

R.M.S.

Kern County

The value of Kern County's mineral production was the highest in the state, and more than 90 percent of this value was in oil and gas. Of the other mineral commodities produced, boron minerals and cement were the more important. Metal mining was confined to gold in the Mojave and the Randsburg districts.

Mineral Fuels. Kern County, in addition to having the highest production of oil and gas, was the most active county in the state in regard to footage of wells drilled. It was also the scene of numerous new pool discoveries and new zone discoveries in proved fields. Of significance was the discovery of a new deep pool by the Standard Oil Company in the Wasco field. The discovery well came in at 330 barrels per day of 38.9 gravity oil from an Eocene formation at an interval between 15,440 and 15,500 feet. This is the world's deep production record.

Nonmetallic Industrial Materials. The Pacific Coast Borax Company mined large quantities of borates, in the form of crude borax (tincal) and kernite, from their property at Boron near Kramer. The extensive deposits of these minerals occur interbedded with Tertiary shales at depths of from 300 to 1000 feet. The deposits of commercial importance underlie a ½- by 1½-mile area. Two mines, the Baker and West Baker, were worked by a room and pillar method of mining. The crude borax, which is in the hanging wall of the kernite deposit, and the kernite were mined separately. These ores were hoisted through vertical shafts, crushed and shipped to the company's refinery at Wilmington, or put through the concentrating and treatment plant at Boron.

The only cement plant in Kern County was operated by the Monolith Portland Cement Company at Monolith. This is a wet process plant having a capacity of 7500 barrels per day. Limestone was quarried from a deposit located about 1 mile north of U. S. Highway 466 and midway between Tehachapi and Monolith. Electric power shovels at the quarry loaded trucks which dump into vertical ''glory holes'' serving an underground haulage system to the crushing plant. Crushed limestone from this 300-ton plant was hauled by diesel locomotive to Monolith. Clay was obtained from a deposit 4 miles northeast of Monolith, and gypsum was mined from a deposit in Ventura County. Wet fine grinding of the clay and limestone resulted in a slurry, 35 percent water, which was pumped to slurry storage tanks then through correction tanks to a storage basin. Cement clinker was produced in five rotary kilns. Two separate clinker grinding circuits were used and the finished cement was stored in silos which have a total capacity of 210,000 barrels.

Clay for rotary drilling mud was produced from the dry lakes in the Rosamond and Muroc areas. The Mojave Corporation excavated silt from a deposit on Muroc lake. This material was hauled by truck to Silt, a station on the Santa Fe Railroad, for screening and shipment. The Antelope Materials Company (Macco Construction Company) produced clay from Buckhorn dry lake. The mining was a seasonal operation, taking place in the spring and fall; the clay then being hauled to the stock pile at Rosamond for processing.

Kaolin, suitable for use as a pottery clay, was produced by the American Mineral Company from a deposit near Jawbone Canyon west of Cantil. The kaolin is a residual deposit derived from the alteration of acidic volcanic rock.

Gypsum, in the form of gypsite, was produced at several localities along the southwest margin of the San Joaquin Valley and was used for agricultural purposes. The largest producer was H. M. Holloway, Incorporated, at Lost Hills. This extensive deposit contains bodies of gypsite as much as 20 feet thick within 3 to 10 feet from the surface. The overburden was stripped off by carryall scraper and the gypsite loaded into trucks by tractors and 4-yard scrapers. This deposit supplied a larger percentage of the agricultural gypsum used in the state than any other single property. The Pacific Gypsum Company produced gypsite from a deposit along the south margin of old Kern Lake. Carryall scrapers were used for stripping the overburden and mining the gypsite.

Sand and gravel was produced by several companies along the Kern River in the Bakersfield area.

Metals. In the Mojave district, the Burton Brothers, Incorporated, cyanide plant treated gold ore from the Tropico, Cactus Queen, Whitmore, and Exposed Treasure (Standard Hill Mines Company) mines and from a few properties in Inyo County. The plant, located at the Tropico mine, has a capacity of 150 tons per day using six rectangular leaching tanks. A jaw crusher and Symons cone crusher reduce the ore to about 1 inch. The crushed ore is ground to 30 to 60 mesh, depending on the ore, in an Allis-Chambers ball mill in closed circuit with a duplex classifier. The pregnant cyanide solution from the leaching units goes to a Merrill-Crowe precipitating plant.

The ore from the Cactus Queen was some which had been mined by Burton Brothers in 1948 and stock piled. The Tropico mine was operated during the year by Burton Mines, Incorporated. Some development work was done from the Kid shaft on the 400 and 750 levels, and a stope was mined between the 750 and 600 levels. Some prospecting and development work was done from the Tropico and Fairview shafts and on some of the parallel veins north of the Tropico or Home vein.

The Standard Hill Mines Company operated the Exposed Treasure and Desert Queen mines on Bowers Hill south of Mojave. Several hundred tons of ore was produced and milled at the Burton Brothers mill. Some ore was produced at the Whitmore mine in the same area.

The Butte Lode Mining Company operated the Butte mine at Randsburg. Ore from here and from other mines in the district, including the Big Dyke, was treated at the Butte mill, a 10-stamp mill with amalgamation plates.

Early in the year some placer gold was recovered in Goler Canyon. The C and H Materials Company recovered placer gold as a by-product in their commercial rock plant on Kern River near Bakersfield.

R.M.S.

Kings County

The larger part of the world-famous Kettleman Hills oil field is located chiefly in Kings County, which ranked seventh as a California petroleum producer. Large quantities of natural gas, natural gasoline, and related products were produced. Gypsite was mined by surface methods in the vicinity of Avenal.

Mineral Fuels. Petroleum production came from the North and Middle Domes of the Kettleman Hills. Rating as a discovery was Standard Oil Company's well No. 27Q, completed in September 1949, which defined the southern limit of Eocene production in the Kettleman Hills North Dome. The well was in the NW$\frac{1}{4}$ of sec. 27, T. 22 S., R. 18 E., 3$\frac{1}{2}$ miles southwest of Kettleman City. Initial production was 24 barrels per day of 47.1 gravity oil from the interval 9905-10,080 feet. Natural gasoline and related products were recovered from wet natural gas at five plants in Kings County, having a combined daily capacity of 318,000 gallons of natural gasoline, and 245,000 gallons of liquefied gases.

Nonmetallic Industrial Materials. Gypsum has been mined for 3 years, 10 miles south of Avenal at the Avenal Gap mine, operated by H. M. Holloway of Lost Hills. The gypsum (gypsite) lies on flat-lying lake sediments. Exploration with rotary core-drills indicates the deposit is irregularly shaped and elongated northwesterly. It is about 2,700 feet long, and 100 to 1,000 feet wide. The gypsum bed is as much as 6 feet thick beneath 2 to 3 feet of overburden. Stripping of the overburden and mining of the gypsum was done with carryalls drawn by Caterpillar diesel tractors. With two carryalls working, 1,200-1,500 tons of gypsum or overburden can be removed in one 8-hour shift. Two loading ramps were used to outload trucks for the agricultural areas where the gypsum was applied to the soil. During the summer months, one man was employed to stock pile gypsum and outload occasional trucks. Winter operations required two men, because most of the shipments were made at that time. The operators usually consider a gypsum bed non-economic where the overburden thickness exceeds that of the gypsum. The material mined here was guaranteed to contain 70 percent gypsum and 13 percent combined sulfur. In the spring of 1950 this material sold for $1.75 per ton at the mine.

J.W.V.

Lake County

The production of sand and gravel at Middletown and Kelseyville was the principal mining activity in Lake County during 1949. In addition, concrete building blocks were made from basalt waste at Sulphur Bank, mineral water for local consumption was bottled at Grizzly Spring, and underground exploration developed some new ore at the Abbott mercury mine.

Nonmetallic Industrial Materials. Camp and Yates produced concrete aggregate and road material from a gravel pit on Dry Creek three-fourths of a mile northeast of Middletown. The gravel, which included many cobbles up to 14 inches in diameter, was composed of quartz, quartzite, brown and red jasper, and diorite. Gravel dug with a dragline to a layer of silt 8 to 16 feet below the surface was trucked about a quarter of a mile to the crushing and screening plant.

Frank and Kennett Evans operated a sand and gravel plant on the west bank of Kelsey Creek about half a mile north of Kelseyville. A

Hough loader equipped with a 1-cubic-yard bucket dug the gravel to water level at a depth of about 5 feet, and the material was hauled in trucks of 5-cubic-yard capacity, about a quarter of a mile to the crushing and screening plant. The capacity of this plant was increased to 400 cubic yards of washed and screened sand and gravel in 8 hours.

The Lang Brothers pit on Kelsey Creek, 7 miles south of Lakeport, intermittently produced commercial sizes of sand and gravel. A bulldozer pushed gravel from the pit into a hopper at the screening plant, which had a capacity of 100 cubic yards per day.

The Aggrelite Company used altered basalt from one of the waste dumps of the Sulphur Bank mine as aggregate for concrete building blocks. In a plant, adjacent to the waste dump, the aggregate was crushed and screened to minus three-eighths inch before being mixed with cement in a conical concrete mixer. The blocks were molded in a Fram vibrating block machine. Capacity of the plant was 2,000 blocks per 8 hours.

Mineral water containing sodium chloride, magnesium and sodium carbonates, and other minerals was bottled at Grizzly Spring. The spring flowed about 2 gallons per minute and the water was piped to a bottling machine with a capacity of 60 dozen 12-ounce bottles per hour. The water was marketed chiefly in the Clear Lake area.

Metals. The Abbott mercury mine was reopened in June. The workings to the 300-foot level were unwatered and the drift was extended 1200 feet to a total length of 1500 feet. The drift, which followed a serpentine-shale contact, encountered some new ore about 1300 feet from the shaft. The ore-shoot was 50 feet long, 4 to 8 feet wide, and dipped 70° southwestward. Some trenches and pits were dug on the surface above the new ore shoot, but no ore was found there. Development work was suspended in December 1949.

J.C.O'B.

Lassen County

Basalt rock for concrete aggregate was quarried near Susanville. Gold quartz claims in the Diamond Mountain district were prospected with trenches, short adits, and shallow shafts.

Nonmetallic Industrial Materials. Basalt rock was mined at the Grayson and Spurgeon quarry 8 miles west of Susanville. Vertical holes were drilled 5 feet deep and at 5-foot intervals with a jackhammer. From 40 to 50 holes were blasted with 40 percent dynamite each week. The broken rock was pulled over a rail grizzly with 10-inch spaces by a $\frac{1}{2}$-yard slusher, and the undersize was crushed and screened. After Harold Grayson purchased his partner's interest in December 1949, the name was changed to Grayson Cement Material Company.

Metals. Gold in the Diamond Mountain district is associated with red and yellow limonite-stained quartz that occurs in veins and stringers, and particularly with minute quartz crystals incrusted with black manganese stains. No shipments of gold ore or bullion were made, but small piles of ore were stored at many prospect cuts, adits, and shafts. Several narrow quartz veins were prospected on the Blue Bell group of claims owned by C. L. Musgrove and M. L. Harris. The quartz veins developed are from 10 to 36 inches wide and strike N. 45° E. in quartz diorite, and in addition, there are quartz stringer zones from 4 to 15 feet wide in quartz diorite which also strike in a general N. 45° E. direction and dip steeply to the southeast. George McDow, Jr., prospected his Gold Belt group of claims with six bulldozer cuts 3 to 4 feet deep and from 20 to 87 feet long. Several quartz stringer zones were cut but no samples were taken. Frank Schmidig extended an adit on the Red Jacket group of claims where the quartz vein, 6 to 8 inches wide, strikes N. 15° E. and dips 80° W. Both walls are quartz diorite. Several tons of ore were piled on the dump awaiting construction of a milling plant. J.C.O'B.

Los Angeles County

More than 90 percent of the mineral substance produced in Los Angeles County during 1949 was petroleum and natural gas. Nonmetallic industrial minerals were next in importance, with the sand and gravel industry being the largest. Over a third of the sand and gravel produced in California is derived from the Los Angeles County deposits. Other important nonmetallic industrial minerals produced in Los Angeles County were clay, diatomite, and iodine. Small amounts of flagstone and granite were also produced. Of the metals, only small amounts of gold and ilmenite sands were obtained.

Mineral Fuels. In 1949, petroleum and natural gas was produced from 33 fields in the county. The most important single discovery during 1949 was the opening of the higher gravity pool in the Placerita field. This pool was discovered by the Somavia and Yant well "Juanita I," which came in flowing 340 barrels per day of 23° gravity oil, 10° higher in gravity than the oil from other Placerita producers. The heightened drilling activity, caused by this discovery, continued until the end of 1949. Activity was further increased by the decision of the California Superior Court on September 23, 1949, which declared the state's Spacing Act unconstitutional and opened about 80 acres of highly subdivided land in this pool to unrestricted drilling. By the end of 1949, the peak of the excitement had passed, and the newly opened pool had about 170 producing wells on it, each pumping an average of about 175 barrels per day.

In the first half of 1949, the northwest part of the Long Beach field on the south side of the fault also experienced a minor boom caused by the discovery of the DeSoto zone. Wells in this zone, which is 10,000 feet deep, averaged initial productions of 115 barrels per day of 28° to 30° gravity oil.

Nonmetallic Industrial Minerals. Cement has been manufactured for some years by the Blue Diamond Corporation in its Los Angeles plant. The company uses clinker obtained from the California Portland Cement Company at Colton, and the Southwestern Portland Cement Company at Victorville. The clinker is crushed and blended in the manufacture of cement.

Clay was produced in Los Angeles County by over 20 operators. No high grade clays are produced, but large quantities of common clay are mined for use in the manufacture of heavy clay products, such as bricks, tile, and sewer pipe, and in pottery.

The only producer of diatomite in Los Angeles County was the Dicalite Division of the Great Lakes Carbon Corporation. The deposit is at Walteria in the Palos Verdes Hills. This is an open pit operation mined with power shovels. The mill, which includes several stages of crushing, drying, and burning, is located on the same property. The product, a finely pulverized pure diatomite, is used as filter, absorbent, and abrasive material.

Small amounts of flagstone were intermittently produced by the Blue Goose Quarry in San Francisquito Canyon. No power machinery was used in this small operation. Mining was carried out by hand, using hammer, crowbar and chisel. Other small quarries produced flagstone from the Modelo shale at various places in the Santa Monica Mountains.

Minor amounts of granite were quarried by Mr. H. A. Jones of Pasadena from a granite-gneiss deposit near Saugus. The rock is used mainly as a rough building stone for walls and buildings, and is occasionally split for flagstone. Extensive fracturing of the rock prevents its use as dimension stone. The quarry is operated intermittently by hand methods.

All of the iodine produced in the United States is from Los Angeles County. Two companies using different processes are actively producing iodine from oilwell brines in the Dominguez, Seal Beach, Venice, and Inglewood fields. The Deepwater Chemical Company at Dominguez uses the silver process. Silver nitrate is added to the cleaned brine, forming a fine precipitate of silver iodide. The silver iodide is coagulated with ferric chloride and allowed to settle, and the clear water is decanted through a sand filter. The sludge, containing silver iodide, ferric hydroxide, and other ferric compounds, is treated with sulphuric acid to remove the ferric compounds. The silver iodide is filtered, washed, and tumbled in a tank containing metallic iron and water. This results in the formation of fine metallic silver in a ferrous iodide solution. The silver is removed by filtering and converted to silver nitrate to be used over again. The ferrous iodide is reacted with potassium carbonate, which forms potassium iodide. This solution is evaporated, yielding crystalline potassium iodide.

The Dow Chemical Company uses a blowing-out process. Clarified oil field waste water is acidified and treated with chlorine to free the iodine. The iodine is removed in a blowing-out tower in which the descending current of water containing free iodine meets a rising current of air. The air current carries the free iodine to another tower, where the iodine is extracted from the air with a solution of sulphurous acid. This results in a mixture of hydroiodic acid and sulphuric acid. The mixture is treated with chlorine, which displaces the iodine. The free iodine is then filtered out of solution.

While iodine is found in the brines of many oil fields in California, only a few have commercial concentrations. Little is known regarding the origin of the iodine, but it appears to occur mainly in oil-bearing horizons of Miocene age.

A large portion of the foundry sand requirements for low temperature castings in the Los Angeles area were supplied by local sources. Several pits of foundry sands were operated during the year, mostly centering around the Torrance-Redondo area. Small amounts of foundry sand were obtained from a deposit near the eastern end of Elysian Park.

The sand and gravel industry is the largest mineral industry in the county except for petroleum and natural gas. Main centers of activity for this industry are in the San Fernando Valley and the San Gabriel Valley, where extensive deposits of sand and gravel have been laid down in the channels and flood plains of Tujunga Creek and the San Gabriel River. Over twenty plants were producing sand and gravel during 1949, most of them in these two areas. Two plants were operating in the vicinity of Long Beach. The large amount of building and construction in the county has resulted in the industry's continued growth and activity.

Metals. Gold was produced from two operations in Los Angeles County during the year. The Hi-Grade mine in Mint Canyon erected a 12-ton mill at its shaft, and by the end of the year had increased the capacity of the mill to 20 tons per day. The mill, operated intermittently throughout the year, is equipped with a jaw crusher, classifier, ball mill, and amalgamation plates. The mine is developed by an inclined shaft to a 210-foot depth, with drifts at the 210-foot, 150-foot and 118-foot levels. The ore is quartz veins containing free gold, and copper sulphides associated with gold.

The Largo Plant of the Consolidated Rock Products Company at Azusa also produced a small amount of gold as a by-product during the washing stage in its sand and gravel operation. The sand and fines are washed down a flume fitted with rubber riffles, which collect the gold and black sands and allow the sand to pass on. The black sand is shoveled from the riffles and sacked every 2 weeks. This material is run over an Anderson rotary motion table to make a final concentrate which is shipped to the American Smelting and Refining Company at Selby, California.

A small quantity of ilmenite was produced by the Ferro-Titan Minerals Company as a by-product of the sand washing section of Consolidated Rock Products Company's Roscoe plant in Sun Valley. The black sands are concentrated from the flow of wet sand by use of black sand recovery pans. Concentrates are dried and then cleaned with a magnetic separator. Most of the equipment used has been developed by the manager of the Ferro-Titan Minerals Company, Mr. Frank Moody of Glendale, California. The black sand plant is able to handle large tonnages of sand, and make quick primary concentrations up to 97 percent heavy sand, which contains 92 percent combined ilmenite and magnetite. The ratio of magnetite to ilmenite is about 55-45 percent. The black sand plant, however, works only when the rock plant works. Most of the product is sold for roofing granules, although small amounts have been sold for use in the manufacture of welding rod, and in the ceramic and pyrotechnic industries.

G.C.H.

Madera County

Three operators produced pumice, two near Friant and one northeast of Lane's Bridge. Gold production was reported from 10 operators, eight of whom used suction dredges. Small quantities of natural gas were produced from the Gill Ranch and Moffatt Ranch fields in the Mendota-Firebaugh area. Plaster and concrete sand were quarried and processed at Firebaugh.

Mineral Fuels. The northwesterly extension of the Moffatt Ranch field was established by Natural Gas Corporation's well ''Moffatt'' in June 1949. The productive interval was 3942-3947 feet in the Eocene. Initial production from this well was 500 thousand cubic feet per day. Some gas was taken from one well in this field during the year. Production came from five wells in the Gill Ranch field, the field being shut-in during the summer months. The Chowchilla field has been shut-in for many years.

Nonmetallic Industrial Materials. California Industrial Materials Company mined pumice from a flat-lying deposit 2 miles northwest of Friant. Overburden averaging 20 feet in thickness was stripped from the deposit. The pumice was drilled and blasted and then loaded into trucks by a one-half yard gasoline-powered shovel for delivery to the company's plant at Friant. At the plant the pumice was dried and sacked for distribution. The principal use for this material was as a filler and carrier for insecticides. Elmer Erickson mined pumice from a deposit 2 miles northwest of Friant. The output was used in his nearby brick plant or sold to other brick makers. A rooter, pulled by a D-7 Caterpillar tractor, loosened the pumice. A screening and pulverizing plant at the deposit produced pumice of minus one-quarter inch size. At the brick plant Flamm machines turned out three brick sizes used most commonly in small dwellings. From 6 to 13 men were employed, depending on the demand for bricks. Pumicrete Product Company operated a pumice pit and brick plant north of Lane's Bridge.

Plaster sand and concrete sand were obtained from gravel dug from the east bank of the San Joaquin River at Firebaugh by the Westside Concrete Products Company. A drag scraper was used to pull the gravel from the pit in the river bed.

Metals. Suction dredges worked stream gravels along San Joaquin, Fresno, and Chowchilla Rivers and Coarsegold Creek to recover gold. A gauge of the capacity of these dredges was the diameter of the digging nozzles they employed. Nozzles range from 2 to 12 inches in diameter. The 2-inch nozzles handled 2 to 3 cubic yards of gravel per hour; 8-inch nozzles handled 55 to 60 cubic yards per hour. Gasoline or diesel engines furnished power for the centrifugal suction pump and other machinery. The gravel and water passed through the pump and were forced to the head of the gold recovery system. A grizzly or trommel was used to eliminate gravel larger than about 1 inch. The fines passed over a series of sluices containing standard gold-saving devices, which included Hungarian riffles, plain riffles, and wire lath. Mercury was used in the riffles of some dredges. Most dredges discharged the tailings through sluices extending 10 to 15 feet behind the stern of the dredge. A new 16-inch dredge will be equipped with a belt-conveyor stacker 40 feet long to handle the coarse tailings. J.W.V.

Marin County

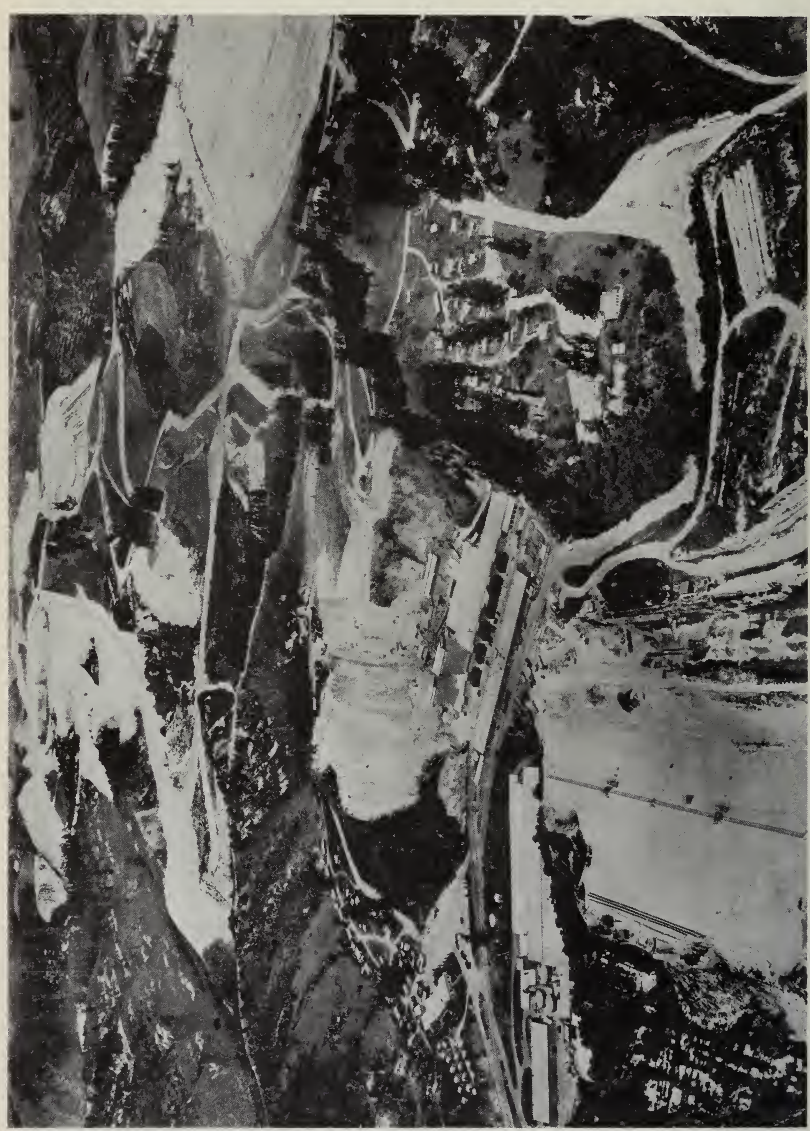
An important part of Marin County's mineral industry centered about Point McNear. Here, clay-shale was quarried for the manufacture of common bricks and Haydite, a lightweight aggregate, and massive sandstone was quarried for jetty construction. Green Brae and Point Reyes Station areas were sources of crushed rock, and Lagunitas Creek deposits provided sand and gravel for aggregate plants.

Nonmetallic Industrial Materials. L. P. McNear Brick Company, operating their plant under lease, manufactured common bricks from clay-shale mined at Point McNear. One large, continuously-fired Hoffman-type kiln was in operation, using Wyoming coal for fuel. Power shovels mined the clay-shale, which is interbedded with sandstone. An average of 35 men were employed regularly.

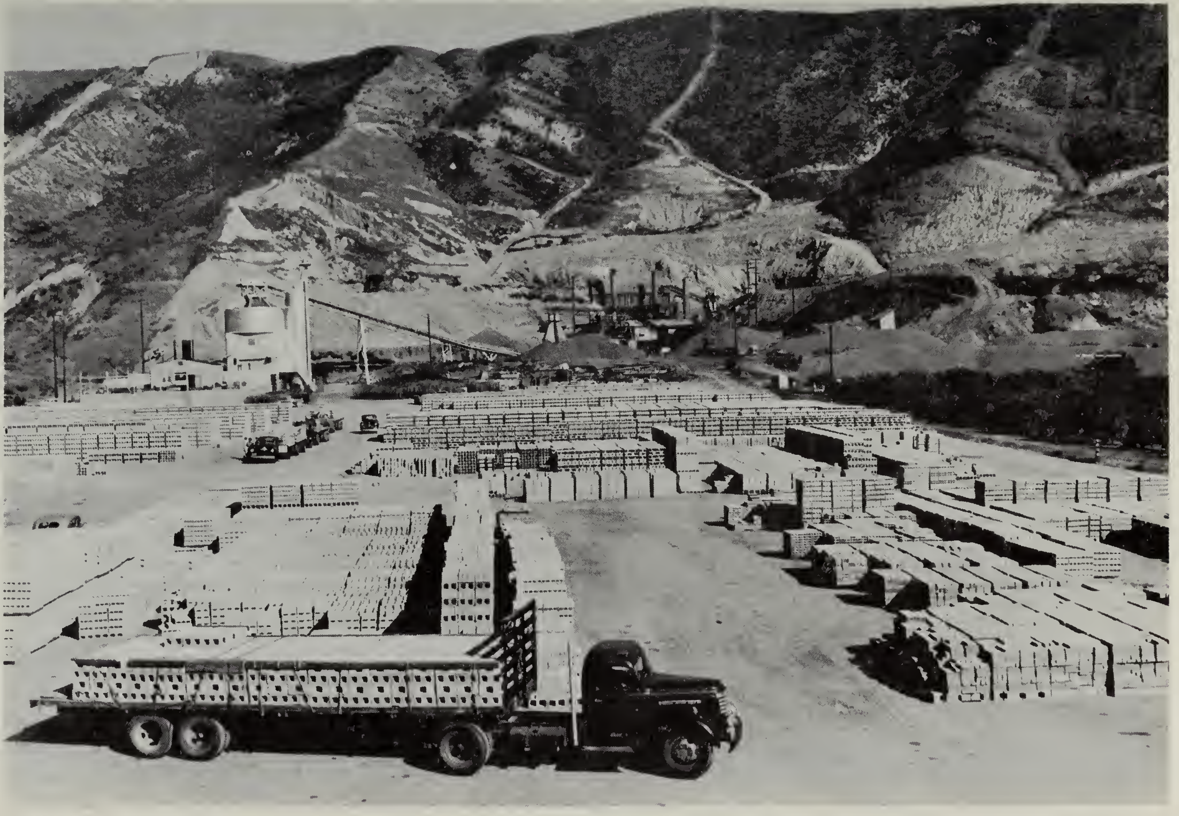
The McNear Brick Company quarried hard, black-colored Tertiary shale, which was expanded to produce Haydite in a plant next to the

A, Quarry and crushing plant, American Perlite Company, Fish Springs, Inyo County. *Photography by Charles W. Chesterman.*

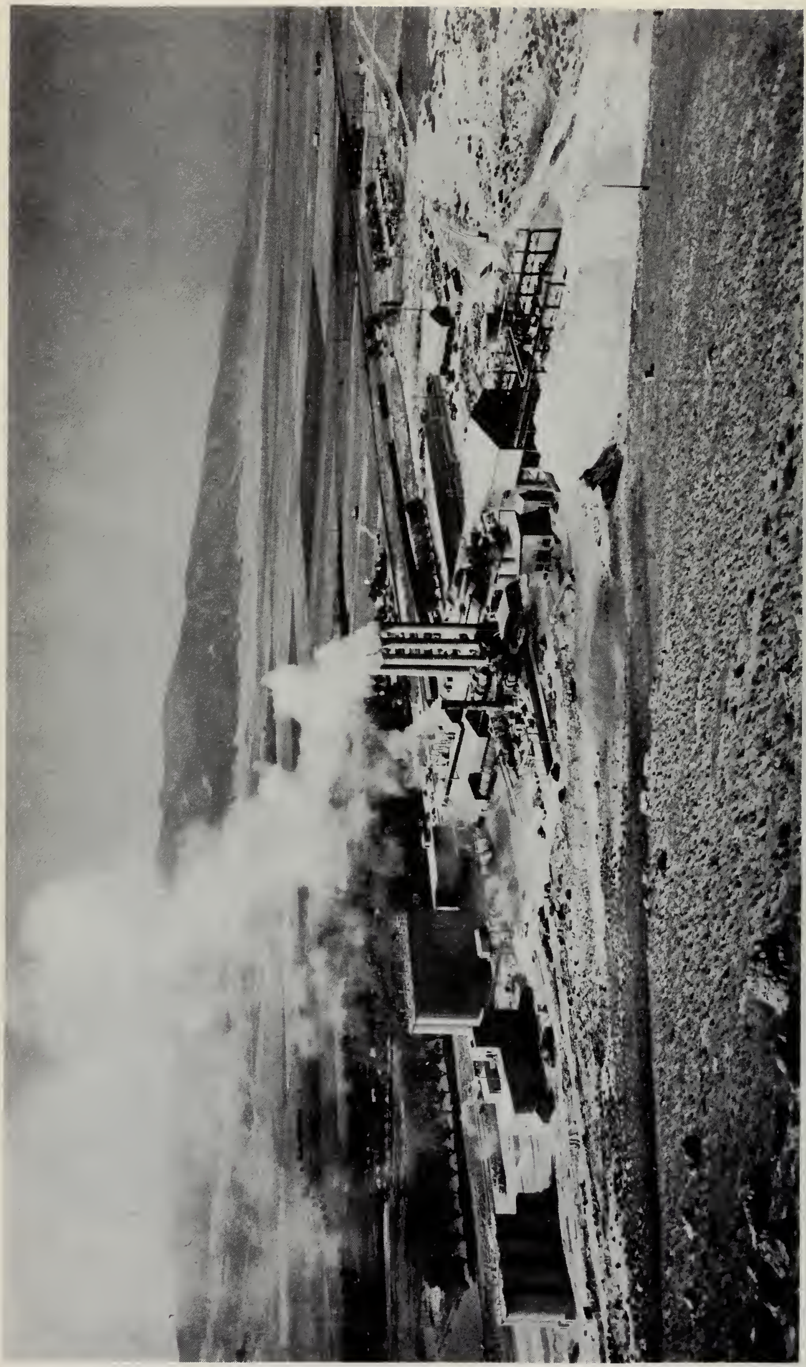
B, Quarry, Redlite Cinder Company, Inyo County. *Photography by Charles W. Chesterman.*



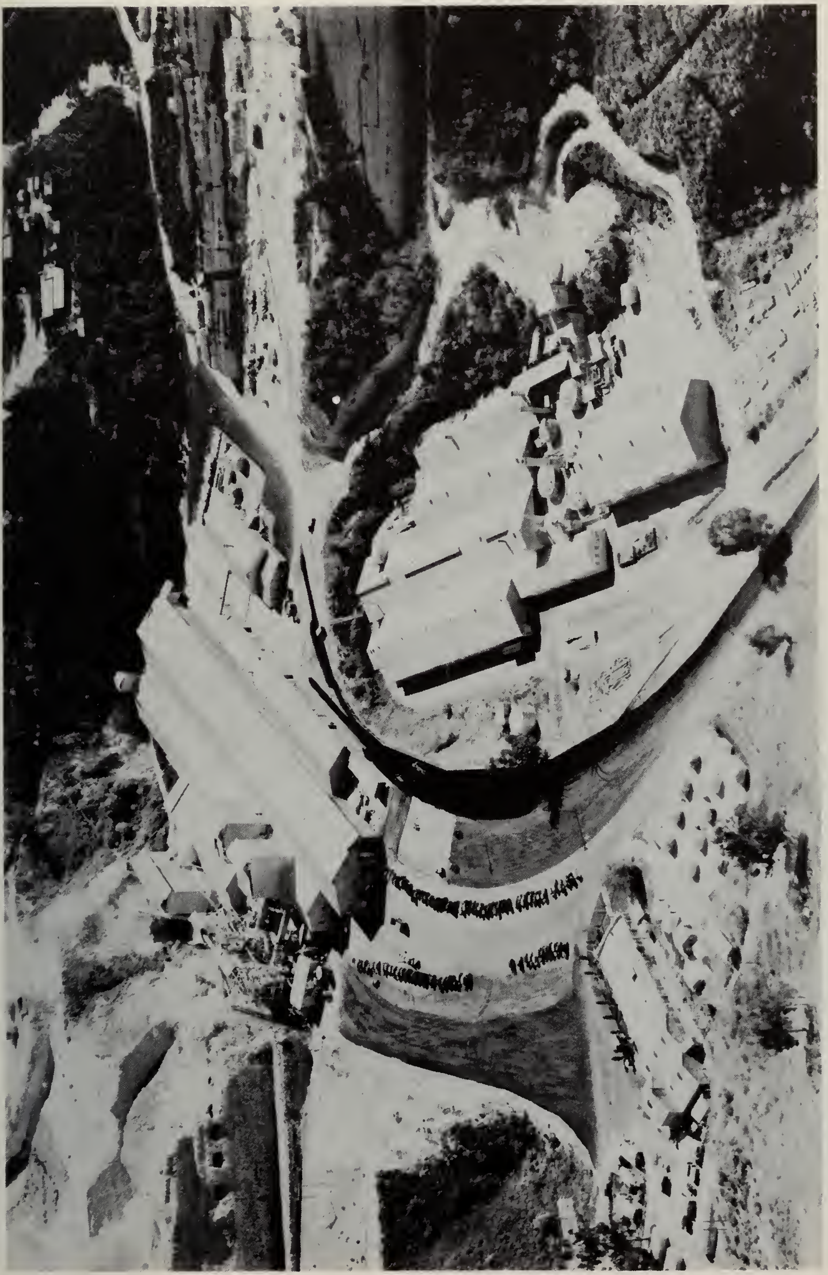
Johns-Manville Celite plant, Lompoc, Santa Barbara County. *Photograph courtesy Fairchild Aerial Surveys, Inc.*



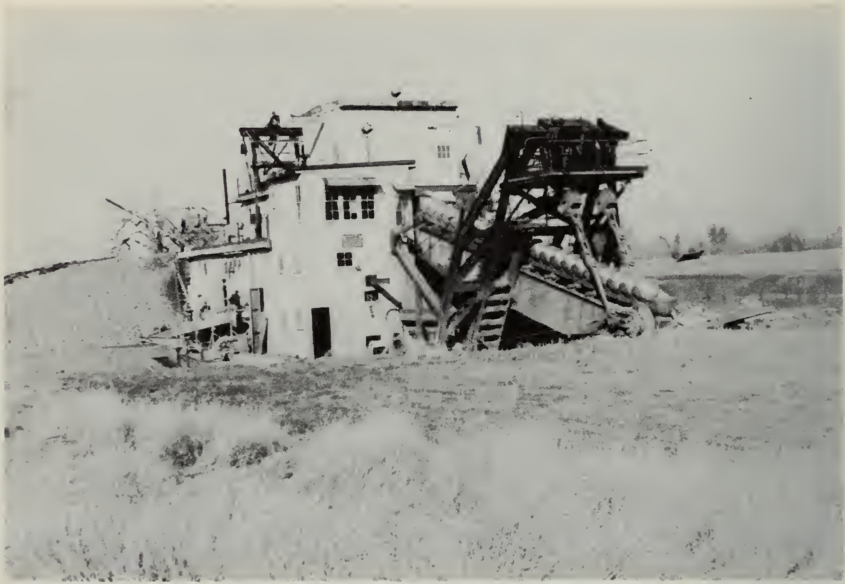
Plant and quarry, Rocklite Products, Ventura, Ventura County. *Photo by Ventura Camera Shop, courtesy of Rocklite Products.*



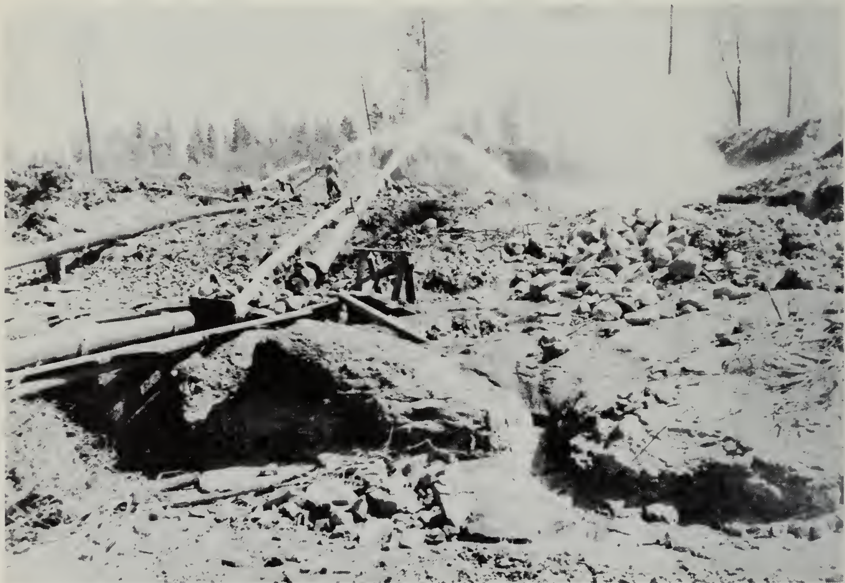
Monolith Portland Cement Company plant, Monolith, Kern County. *Photo courtesy Monolith Portland Cement Company.*



Johns-Manville Celite plant, Lompoc, Santa Barbara County. Powder products section in the center. Brick processing section to the right of parking area. *Photo courtesy of Johns-Manville Products Corp.*



A, Bucket-line dredge, Yuba Consolidated Gold Fields, Butte Creek south of Chico, Butte County.



B, Hydraulic mining at the Rex mine near Weaverville, Trinity County.

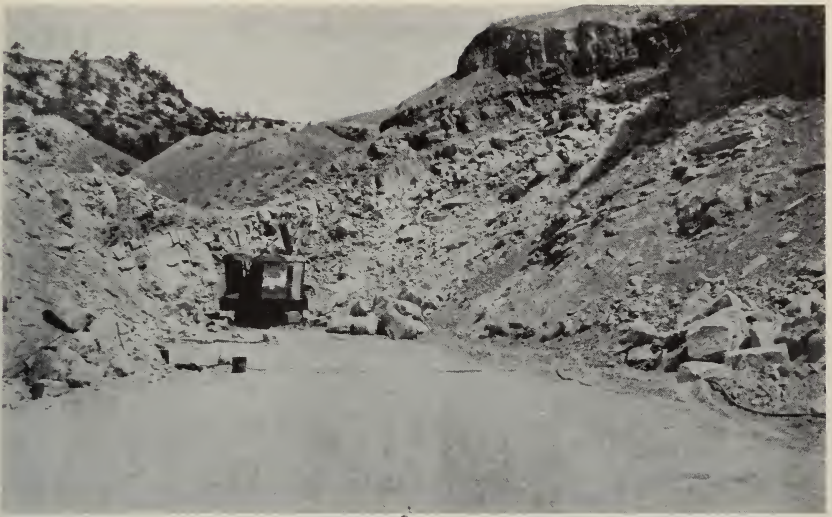
BASALITE
BASALT ROCK CO INC

A, Basalite plant, Basalt Rock Company, Stockton, San Joaquin County.

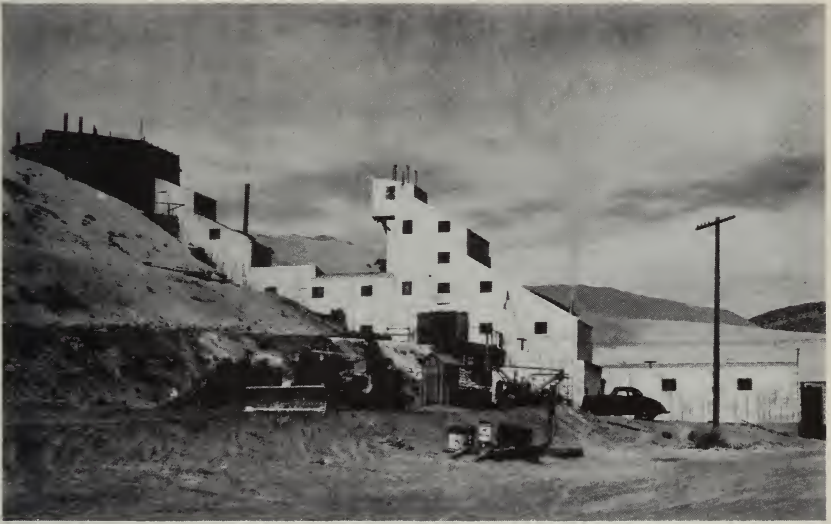
B, Loading a kiln, Sacramento Brick Company, Sacramento County. Note use of brick fork moving a "package" of 1,024 bricks.

A, Mill, Sarita Milling Company, Chemung mine, near Masonic, Mono County.

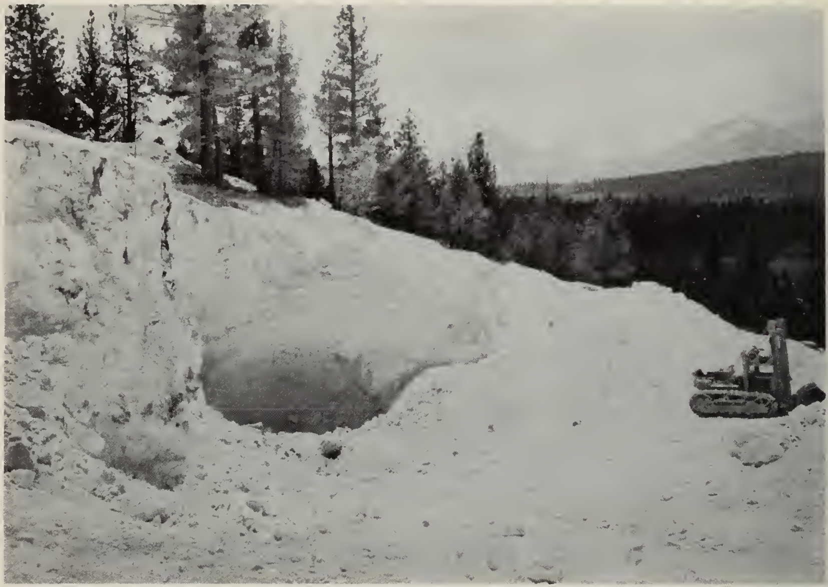
B, Sarita mine, near Masonic, Mono County.



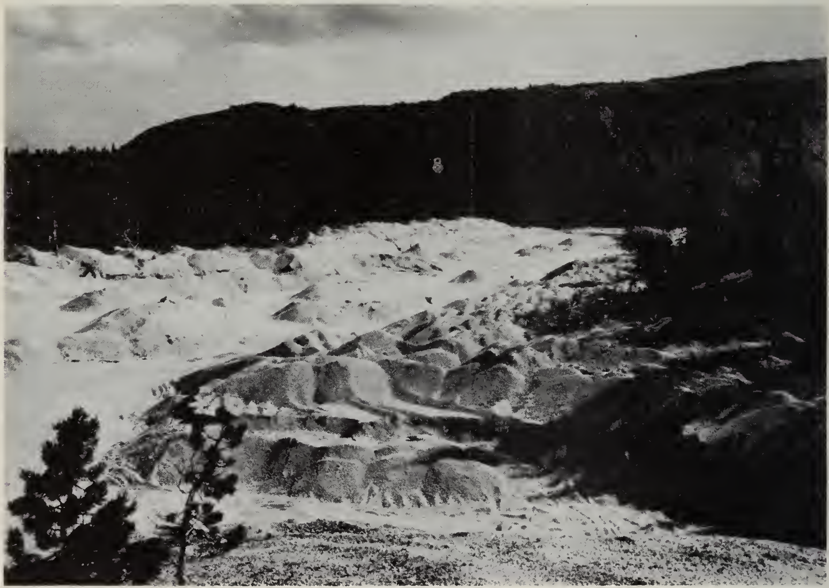
A, Gypsum quarry, Monolith Portland Cement Company, Quatal Canyon, Ventura County. *Photography by William E. Ver Planck, Jr.*



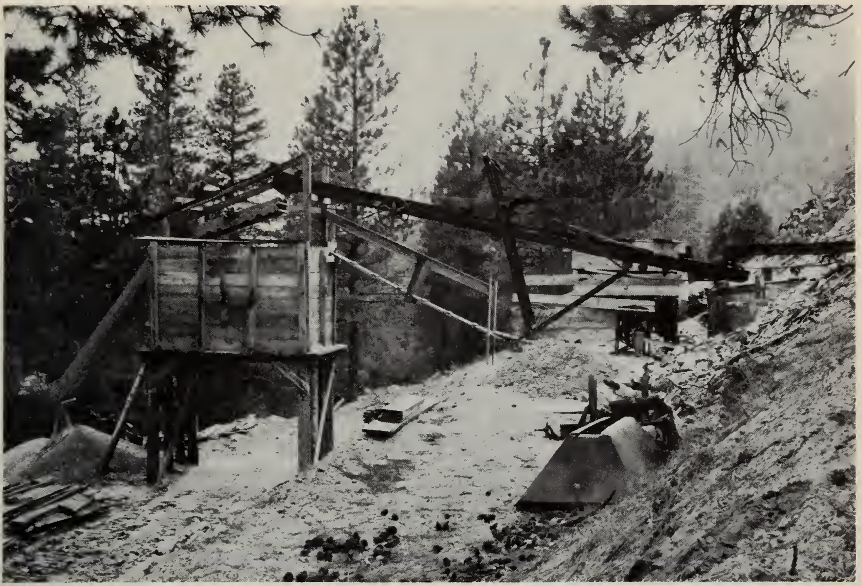
B, Processing plant, Insulating Aggregate Company, Mono County. *Photography by Charles W. Chesterman.*



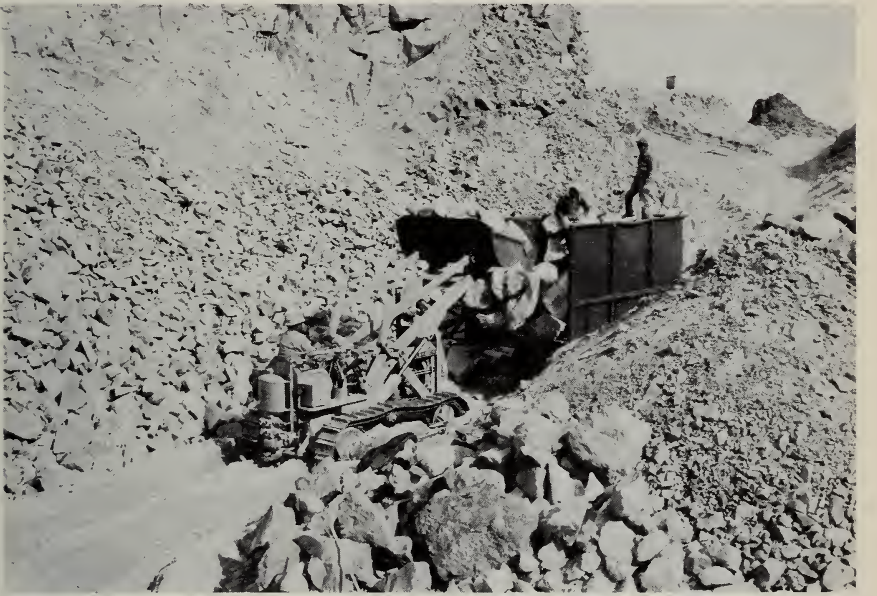
A, Kaolin deposit, Huntley Industrial Minerals, Inc., near Casa Diablo Hot Springs, Mono County.



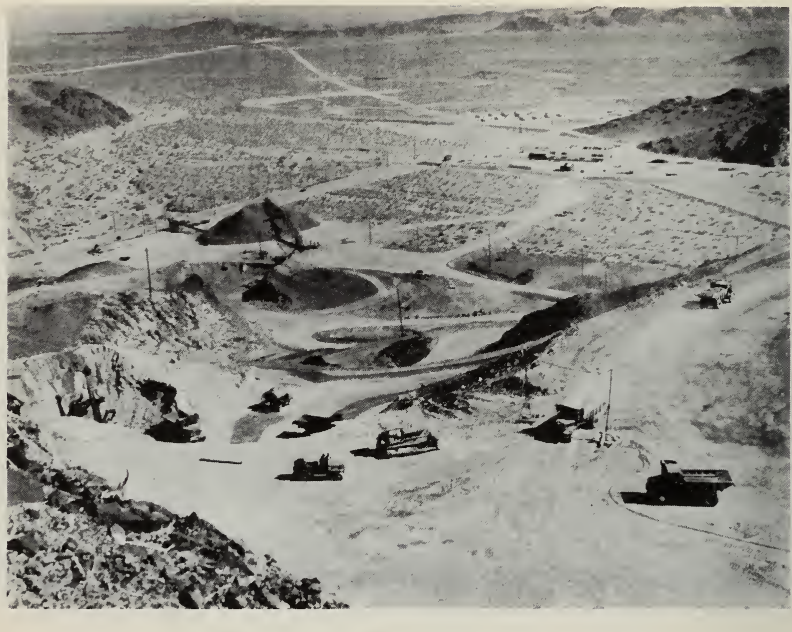
B, Pumice quarry with obsidian flow in background. Fouch pit, Glass Mountain, Siskiyou County. *Photography by Charles W. Chesterman.*



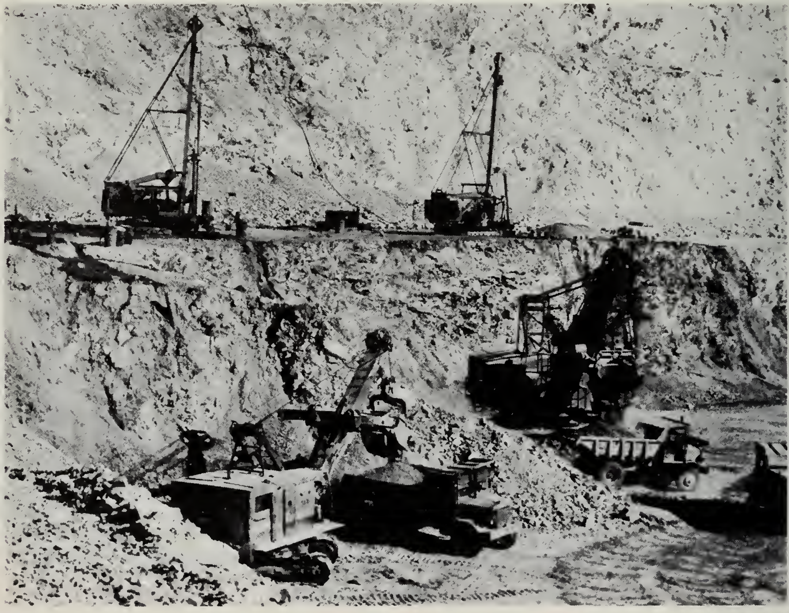
A, Quarry and screening plant, Structurelite Company, Davis Creek, Modoc County. *Photography by Charles W. Chesterman.*



B, Loading black pumice at quarry, U. S. Pumice Supply Company, Mono County. *Photography by Charles W. Chesterman.*



A, Eagle Mountain iron deposit, Kaiser Company, Inc., Riverside County. Looking southeastward, with operating quarry in foreground, stock pile of crushed ore and loading facilities at left of center, and office and living quarters in background. *Photo courtesy of Kaiser Company, Inc.*



B, Eagle Mountain iron deposit, Kaiser Company, Inc., Riverside County. Photograph showing the bench system of mining employed. In the background are the churn drills in operation, and in the foreground are the electric shovels loading ore into trucks to be transported to the stock pile. *Photo courtesy of Kaiser Company, Inc.*

brick plant. Black shale was quarried from several benches, where the Tertiary shales and sandstones are adjacent to Franciscan sandstone along a probable fault contact. The shale in the quarry area is contorted and crushed. After loosening it was allowed to air-slake in the pit for several months to enhance its expansion properties. At the plant the shale was crushed to minus 2½ inches (the most desirable size is 1¼-1½ inches) and run through a rotary oil-fired kiln 60 feet long. The maximum temperature usually attained in the kiln was 2900° F.; while in the kiln the shale expands to a porous, slag-like mass. The kiln material was discharged to a traveling grid-conveyor that transferred the expanded shale to an open-air cooling area. After cooling, the Haydite was moved by a dragline to a crushing and screening plant. Haydite was sold for about 5 dollars per cubic yard at the plant.

The Basalt Rock Company quarry at tidewater on Point McNear produced rock for levee and jetty construction. Two pits in hard, massive, gray-colored Franciscan sandstone have been opened and a modern crushing plant and barge-loading system have been installed.

The operations of the Hutchinson Company east of Highway 101 near Green Brae embraced two quarries, a rock crushing and screening plant, storage bunkers, a hot asphalt plant, and barge-loading facilities. Hard, massive, green-gray-colored Franciscan sandstone was the principal rock produced here. The daily capacity of the rock plant was 1500 tons; the asphalt plant capacity was 450-500 tons per day. Forty-five men were employed, and the connected horsepower of the plant was 1035.

Crushed rock, asphalt sand, and gravel were supplied in the Tomales Bay area by the Marin Gravel Company located 3 miles east of Point Reyes Station at the foot of Black Mountain. The rock quarry here was in red chert, vesicular basalt, shale, and sandstone of the Franciscan formation, which strikes N. 20° W., and dips 20° E. Material for the gravel plant was obtained from the confluence of Lagunitas Creek and Arroyo Nicasio, using a dragline scraper. J.W.V.

Mariposa County

Gold was the principal mineral product of Mariposa County and the largest lode mine production was from the Hunter Valley district. Several mines along the Mother Lode also produced gold ore. A number of gold mines were active in the East Belt and small production was made. Placer mining for gold was limited to the operation of a suction dredge, two dragline dredges, and several small hand-worked deposits. Silver, platinum, and copper were produced as by-products of gold mining. Sand and gravel for road building and slate for flagstone were quarried at five localities. Diamond-drill exploration disclosed a new barite lens at the El Portal deposit.

Nonmetallic Industrial Materials. Slate for facing and flagstone were quarried at Le Grand by the Hanner Mining Company and at Mt. Bullion by the Mt. Bullion Slate Company. The Mt. Bullion quarry was operated in vertically dipping black slate on the Trabuco Ranch, about 3 miles west of the town of Mt. Bullion. After overburden was removed from the deposit, slabs of slate were removed by wedging. The product was shipped to consumers in central and southern California.

Sand and gravel for road construction were produced by the County of Mariposa and Yosemite National Park. Gordon Greenauger operated a commercial aggregate plant.

Extensive exploration was begun during the year by the Baroid Sales Division, National Lead Company, on the El Portal barite deposits. The deposits are on the north side of the Merced River a mile west of El Portal, near the partially dismantled barite processing plant. Diamond-drill holes intersected a new barite lens and plans were laid to explore it with a cross-cut and raise during 1950. The new deposit is one of three barite lenses that strike almost due north and dip 85° W. in the metamorphosed Calaveras formation. The other two barite lenses were already known and had been worked.

Metals. The Mt. Gaines mine near Hornitos, one of the most important mines in the Mother Lode counties, operated until June 28 when activity at the mill and in the main part of the underground workings was suspended. Some development work was continued until October 1 when the mine was completely closed and allowed to flood. Development work in 1949 consisted of 450 feet of drifts and 243 feet of tunnels. The ore was crushed, run through a battery of stamps, and the free gold was amalgamated. The discharge from the stamps passed to flotation cells and then to Wilfley tables. The concentrate produced contained gold, silver, and copper and was shipped to the American Smelting and Refinery Company's smelter at Selby for refining. The Big Slide and the Domingues mines near Hornitos each made some production of gold during the year.

The old Mariposa mine, half a mile east of Mariposa, was the first gold-quartz mine in California. It was discovered in August 1849 and was active almost continuously until 1915. It was purchased in February 1949 by Frank E. Gallagher from the Mariposa Commercial and Mining Company. Gallagher planned to build a mill and begin operation of the mine during 1950. Mines along the Mother Lode which produced gold ore included Argo, Barrett, Combination, Kentucky Hill, Lonesome Pine, Malone, Pendola Garden, Specimen, and Texas Gulch.

The Marble Springs mine in the East Belt started operations on September 21, 1949, after being closed since 1937. The ore consisted of free gold and gold-bearing sulfides in a quartz vein and was worked through a 418-foot inclined shaft. The ore was crushed and fed into a rod mill where the free gold was amalgamated. The sulfides were concentrated by flotation.

The Permit and Nutmeg mines were operated by the Permit Mining Corporation from April until the end of the year. They are located on Whitlock Creek, about 4 miles north of Mariposa. The Diltz-Oro Grande mine, a mile east of the Nutmeg, was worked for the entire year.

The Schroeder mine, about 2 miles northeast of the Diltz-Oro Grande, was worked from January 1 to December 1. Development work at the Schroeder extended the main tunnel 120 feet during 1949. The ore in the Schroeder consisted of free gold and galena in vein quartz. The vein strikes a little north of west and dips 27° N. The ore was trucked to a mill on the property where it was crushed in a primary jaw crusher and ground in a 20-ton Huntington mill. The mill discharged over an amalgamating plate and a small riffle. About 90 percent of the gold was recovered by amalgamation in the mill. Other East Belt mines producing gold during the year were the Blue Ribbon, Good Gulch, and Mexican Diggings.

The Ernest Noble suction dredge worked during April in stream gravel on the West Fork of the Chowchilla River. In the Mother Lode district the James H. Henry dredge worked from January through May on Bear Creek, 3 miles west of Mt. Bullion. Equipment consisted of a Koehring diesel excavator which delivered gravel to a floating washing plant. Thurman and Wright Dredge No. 3 worked bench gravel along Burns Creek, near Hornitos, from February to August. Here a Bucyrus-Erie electric-power shovel excavated gravel for a Bodinson electric washing plant. This was the largest dredge operation in the county.

M.D.T.

Mendocino County

The production of sand and gravel for concrete aggregate and road construction at Ukiah, Fort Bragg, and Williams, was the chief mining activity. Carbon dioxide gas was produced at Hopland and converted into dry ice.

Nonmetallic Industrial Materials. The seventh of a series of carbon dioxide wells was drilled to a depth of 790 feet and put into production in the Hopland field by the Cal-Dri Ice Corporation. Rotary drilling was used, and casing was set for the entire distance. The diameter of the new well was reduced from 12 inches at the top to 8 inches at the bottom. Water at a temperature of 185° F. accompanied the gas. After the water had been removed in metal tank separators, the gas was compressed in two stages to a pressure of 550 pounds per square inch. It was then dried by passing it over calcium chloride crystals, purified with carbon and other reagents, and liquefied in ammonia condensers. Carbon dioxide ''snow,'' formed by discharging the liquid into a chamber at 135 pounds per square inch pressure, was pressed into cakes in a hydraulic press under a pressure of 2,000 pounds per square inch. Cakes of dry ice measured 10 by 10 by 12 inches and weighing 60 pounds were double-wrapped in paper for delivery to consumers. The plant had a capacity of 360 cakes per day.

The Ukiah Gravel and Cement Company was operated at Ukiah by John Freitas and Son during the year. Sand and gravel was dug from a bar on the Russian River with a dragline equipped with a one-half yard bucket. The gravel from this deposit includes subangular pebbles of quartz, quartzite, sandstone, brown and red jasper, and conglomerate. The material was loaded into dump trucks and hauled about a quarter of a mile to the crushing and screening plant. This company consumes part of the aggregate output in its concrete batching plant, which was enlarged in 1949.

Sand and gravel was also produced by Kirby Ford at Ukiah, and at plants in Fort Bragg and Willits. J.C.O'B.

Merced County

Two bucket-line dredges recovered gold from channels of the Merced River near Snelling. Sand and gravel was produced at Los Banos, Winton, and Ballico.

Nonmetallic Industrial Materials. The Los Banos Gravel Company has discarded the slack-line cableway formerly used to mine their deposits, and are using a Byers caterpillar-mounted gasoline shovel with a one-half yard dipper. Dump trucks haul the material to the screening plant where a $1\frac{1}{2}$-inch scalping screen passed oversize to a 15 by 30-inch

Straub Kue Ken jaw crusher. The lower deck of the scalping screen removed $\frac{3}{8}$-$1\frac{1}{2}$-inch gravel, discharging it to an inclined conveyor belt feeding a trommel atop the storage bunkers. This gravel was washed in the first section of the trommel. The minus three-eighths inch was processed for sand by a dewatering wheel and a sand drag, with fine sand being recovered by the latter unit.

The River Rock Company of Merced have added an asphalt plant to their operation on the Merced River, 12 miles north of that city. Plant mix is made in addition to their regular line of sand and gravel products. The Merced Sand and Gravel Company (J. C. Halbert) operated a dragline near Winton, and produced sand and gravel products. This material was run through a crusher, washed, and graded.

Metals. Gold dredging operations have been active along the channels of the Merced River in the vicinity of Snelling. The Snelling Gold Dredging Company was operating its unit No. 1 on the north side of the Merced River, about a mile north of Snelling. This boat was a Yuba-type, electrically operated, connected-bucket dredge. The bucket line contained 66 buckets of 7-cubic-foot capacity. The Merced Dredging Company operated its No. 1 dredge on the north side of the Merced River about 1 mile south of Snelling during the first quarter of the year. This was an electrically operated dredge of the connected-bucket-line type. The line contains 60 buckets of $9\frac{1}{2}$-cubic-foot capacity. The Mid-State Equipment and Dredging Company of Le Grande operated a dragline dredge intermittently in this vicinity. A small quantity of by-product gold was recovered by the Merced Sand and Gravel Company at its plants near Winton.

F.F.D.

Modoc County

The manufacture of pumice blocks constituted the greatest activity of the mineral industry of Modoc County during 1949. Peat moss, tuff, and sand and gravel were produced in addition to pumice. At two gold mines in the High Grade district, prospecting and development were carried out.

Nonmetallic Industrial Materials. The Modoc Peat Moss Company produced peat from beds of hypnum moss found east of Likely. The moss, which accumulates at a rate of about a quarter of an inch a year, occurs in a 4 to 6-foot layer, which rests on a fine-grained gray material, probably volcanic ash or tuff. A 20-acre tract was drained by digging ditches around the area with a dragline and pumping the water into a 2-mile canal that flowed into the Pit river. A tractor-drawn machine equipped with rotating blades stripped off the peat in 10 to 12-inch layers and shredded it. When it had thoroughly dried, a scoop-conveyor loaded it into a trailer truck for delivery to a stock pile. Trucks of 20 and 30-cubic yards capacity were loaded from this stock pile with a conveyor belt-type loader and the peat transported to stock piles along the Southern Pacific Railroad tracks at Likely. Box-cars were loaded by pushing the peat to a conveyor belt, which fed it to a belt-type loader and piler. During 1949 some of the peat was processed in a plant at Likely that included grinders, compressors, and balers. A grinder with four sets of rotating blades cut the peat into 1-, $\frac{7}{8}$-, and $\frac{1}{2}$-inch lengths. The balers compressed the processed peat into 110 to 115-pound bales, wrapped in waxed paper cartons. The 1-inch and $\frac{7}{8}$-inch material was sold principally for poultry litter, while the half-inch size was used by horticulturists. Fines from the grinders were packed in sacks of 2¼ cubic feet capacity and sold for use as a mulch in hot houses and nurseries. Capacity of the plant was 200 bales a day.

The Boorman Pumice Products Company operated a crushing plant at Tionesta equipped with 12 by 22-inch rolls set to crush to minus one-fourth inch. Crushed pumice shipped by truck to northern California pumice block manufacturers constituted 25 percent of the output; the remainder was shipped by rail. At the Thompson and Gordinker plant in Tionesta, pumice crushed to minus three-eighths inch with 15 by 12-inch rolls was loaded into railroad cars or trucks by conveyor belt. Capacity of the plant was 39.5 cubic yards per hour. E. L. Myrick leased and operated the Glass Mountain Volcolite Company pumice block plant at Tionesta. Pumice purchased from Tionesta dealers was made into blocks with vibrating-type machines. The Glass Mountain Brick Company manufactured pumice blocks from pumice purchased from dealers in Tionesta. The plant, about 7 miles east of Tionesta, was operated one shift a day for 9 months during the year. In August 1949, Clyde Cole took over a pit previously operated by L. E. Foster near the Southern Pacific Railroad's Surprise station, about 10 miles northeast of Alturas. Volcanic sand or tuff was mined with a Fresno scraper and loaded into trucks from a trap built of timbers. Most of the output was used for bedding in cattle cars, the balance being shipped in gondola cars for other uses.

The Moyer Gravel Company worked a gravel deposit 2½ miles east of Alturas and south of the highway. The gravel bed averaged 6 feet in thickness and contained rounded pebbles and many 10 to 12-inch cobbles of trap rock. About 2 feet of overburden was removed with a carryall before a power shovel excavated the gravel down to the underlying hardpan. A plant equipped with a gyratory crusher, rolls, trommel, and drag classifier produced washed sand, gravel, and crushed rock.

Metals. The Klondyke mine in the High Grade district was worked by eight mining engineering students during the summer. The work was divided between prospecting outcrops with trenches and shallow shafts and remodeling the mill. A 4 by 4-foot ball mill was substituted for the rolls, while two Humphrey spiral concentrators were added to treat minus 16-mesh material. No production was made, although it was planned to ship future concentrates to a smelter.

At the Moonlight mine in the High Grade district development work was continued by Wellman Smith and associates. Gold, together with some pyrite and arsenopyrite, occurs along a shear zone in a rhyolite breccia that had been recemented by silica from the ore-bearing solutions. The breccia is composed of pink, red, tan, white, and gray angular fragments. From 4 to 18 inches of ore with many vugs and small crystals of dark brown-stained quartz clings to the walls. The highest grade of ore is a soft, earthy, brown material containing angular fragments of quartz and rhyolite. The shear zone has been prospected with shafts and bulldozer cuts 8 feet deep spaced at 50-foot intervals. During the year a second prospect shaft was sunk in the shear zone 90 feet south of the shaft from which some high-grade ore was mined in 1947 and 1948. Ore produced from these openings was stock piled.

J.C.O'B.

Mono County

Output of nonmetallic materials continued to lead mineral production in 1949. Construction of a new gold mill at the Chemung mine near Masonic, however, was outstanding among recent developments. Pumice operations ranging from the south shore of Mono Lake to the southern border of the county produced a variety of aggregate and abrasive materials. Kaolin from the Casa Diablo Hot Springs area and pyrophyllite from two deposits on the lower slope of the White Mountains added to total mineral production. Gold mining was active in the Masonic district; tungsten operations were limited to a small production and limited exploration.

Nonmetallic Industrial Materials. The pumice industry in Mono County is outstanding for its variety of products. Lightweight concrete aggregate, plaster aggregate, abrasive media, scouring blocks, and containers for plant culture are among the several items.

United States Pumice Supply Company, Inc., quarried block pumice from two localities near Leevining. The deposits located near the southern edge of Mono Lake were worked by open-pit methods. Overburden was removed by a carryall; the pumice was then drilled and blasted into blocks as much as 5 feet in diameter, which were hand-sorted and transferred to a truck-loading bin by a Traxcavator. The plant at Leevining uses saws and other equipment to produce two nationally-known products, Grillmaster, a scouring block for griddles, and Plantmaster, a shaped pumice container for growing plants.

Delta Pumice mine, about 10 miles southeast of Casa Diablo Hot Springs, operates an aggregate and block plant. Pumice was mined from an open cut with a skiploader and transported to the adjacent plant. The unconsolidated pit-run material passed over a 4- by 8-foot vibrating screen, with the minus three-quarter-inch product falling directly into the block storage bins. Capacity of the block plant is 2,300 blocks per day. The blocks are water-cured for 17 days before marketing. Insulation and plaster aggregate products were produced by passing crude pumice through a trommel, the screen size on which was varied to meet consumer specifications.

Benton Pumice Company was producing as much as 400 tons per month of aggregate material from their deposit south of Old Benton. Here two pumice beds are separated by 3 feet of clay. The upper bed, 15 feet thick, contains material as large as 1½ inches; the lower bed, 10 feet thick is composed principally of fine material. A bulldozer was used to excavate the pumice and deliver it to a receiving bin from which it passed over a shaking screen for sizing. Production in 1950 was a mixture of minus three-eighths-inch to plus nine mesh pumice that was consumed in Los Angeles for pumice-block manufacture.

Insulating Aggregates Company's modern plant, 6 miles north of Laws, produced several types of blended plaster aggregate and abrasive materials. Pumice used was mined from a large deposit adjacent to the plant. The extensive bed of white, fine-grained pumice is as much as 15 feet thick and is overlain by a pinkish brown-colored tuff.

H. A. Van Loon worked a pumice deposit in the Yellowjacket Springs district. Material was transported to Bishop for use as an aggregate in concrete blocks and slabs.

Pyrophyllite was mined from two properties along the lower west slope of the White Mountains east of Shealy rail siding. The pyrophyllite occurs in a zone of highly metamorphosed rocks in the vicinity of the abandoned Champion Sillimanite, Inc., andalusite operation. Huntley Industrial Minerals, Inc., worked a deposit at the north end of the zone. The raw material was mined by open-pit methods and loaded with a power shovel into trucks for delivery to the company's grinding plant at Laws, Inyo County. Charles Bowen moved pyrophyllite from a deposit 2 miles south of the Huntley property. Most of the pyrophyllite production is consumed as an insecticidal carrier; some was used as material in red-burning tile.

Kaolin was produced by Huntley Industrial Minerals, Inc., from a newly developed deposit in the Little Antelope Valley east of Casa Diablo Hot Springs. The clay, derived from altered, acidic volcanic rocks, was worked by open-cut methods. After drilling and blasting, the clay was loaded by a skiploader into trucks for delivery to the company's grinding plant at Laws. The finished product was marketed for filler material in paper and rubber products.

Metals. Metal mining in Mono County was stimulated by the construction of a 100-ton gold mill at the Chemung mine by the Sarita Milling Company. This company contracted to build the mill and to treat ores from properties leased by Sarita Mining Company. Several formerly prominent mines are held by the latter, some of which are the Sarita, Chemung, Pittsburg-Liberty, and Lakeview. The Sarita Milling Company had also contracted to mine ore at the Sarita mine.

In mid-1950, a 200-foot adit had been driven at the Sarita property to intersect the crushed ore zone. Ore was drawn from that point, loaded into mine cars by a mucking machine, and trammed to a loading bin from which it was trucked to the mill. Beneficiation was by cyanidation and consisted of two-stage crushing, fine grinding in a ball mill to minus 100-mesh material, thickening and agitation. The leaching cycle was 36 hours with a 92 percent recovery for a $12.00 per ton heads assay. An estimated 80,000 tons of similar grade ore had been developed at the Sarita mine by July, 1950.

Tungsten Associates, Limited, continued exploratory and development work at their tungsten property near Saddlebag Lake. No. 1 tunnel workings were extended 400 feet, of which about 135 feet was drifting in ore assaying 1.2 percent WO_3. A second exploratory adit was started in late 1949.

Tungstar Corporation treated 1,000 tons of tungsten ore mined from the Black Rock mine 8 miles south of Benton. Scheelite ore occurs along a contact between carbonate rock and dacite. The property had been worked extensively in previous years.

Two small shipments of gold ore were made from the Sacramento mine 11 miles north of Laws on the west slope of the White Mountains.

L.A.N., Jr.

Monterey County

A large quantity of dolomite was quarried and calcined at Natividad. Calcined dolomite was combined with sea water at Moss Landing to produce a line of magnesia products, some of which were used in the manufacture of basic refractories at the same locality. Salt was also obtained here by solar evaporation of sea water. Dune sand was mined at Moss

Beach and processed for industrial use. Production of low gravity petroleum was made near San Ardo. Asphalt sand, carmel stone, and small quantities of gold and silver were produced in this county.

Mineral Fuels. Oil development continued on the east side of the Salinas River, 6 miles south of San Ardo. About 800 acres had been proved by June and 46 producers were on record. Some additional wells were shut-in owing to the low price offered for the 12° gravity oil produced from this field. Production was from stratigraphic traps in upper Miocene sands at a depth of about 2200 feet.

Nonmetallic Industrial Materials. The Kaiser Aluminum and Chemical Corporation (formerly Permanente Metals) produced large quantities of dolomite from its Natividad quarry about 6 miles northeast of Salinas. The quarry is located in dolomite of the Sur series, which is intruded by pre-franciscan Santa Lucia granite. Granite dikes, sills, and apophyses are distributed irregularly through the dolomite body. The dolomite is white, coarse crystalline, and massive. The quarry workings have been merged into one bench about 200 feet wide, 1,000 feet long, and 200 feet high. Granite in the quarry-run rock was so friable that it was reduced to minus three-fourths inch size by the crusher, fell through the screens, and was conveyed to the adjoining hillside waste dump. The quarry employed five men and output was rated at 1200 tons per day. At the calcining plant the dolomite was washed, recrushed, and the minus three-eighths inch dolomite was calcined at a temperature of about 1100° C. in an 8- by 308-foot gas-fired counter-current Schmidt kiln, equipped with Unax cylindrical coolers. The $\frac{3}{8}$- minus $\frac{3}{4}$-inch dolomite was deadburned at a temperature of about 1700° C. in a second Schmidt kiln. This product was used in granular form for the repair of steel furnace linings.

The company's magnesia (MgO) plant at Moss Landing combined the calcined dolomite ($CaO \cdot MgO$) from Natividad with sea water from Monterey Bay to produce a line of magnesia products ranging from light-burned magnesia to special high temperature periclase. The process involved pre-treatment of the sea water; chemical reaction with calcined dolomite (re-ground to minus 20 mesh); thickening, washing, and filtering of the magnesium hydroxide ($Mg(OH)_2$) formed in the reaction; and decomposition of the hydroxide by calcination in a Schmidt kiln. The magnesia products were used in the rubber, chemical, rayon, paper, and fertilizer industries, as well as in the manufacture of basic refractories. The magnesia plant operated on three shifts daily, 7 days per week, employing 25 men. Basic refractories were also produced by the company in an adjoining plant at Moss Landing. Periclase and some California chrome ore were combined in varying percentages to make chemically bonded bricks, most of which were sold unburned for use in cement kilns, copper converters, steel open-hearth and electric furnaces. Some burned brick was fired in a periodic tunnel kiln for use in ladles. Patching and ramming mixes were also made.

Dune sand, derived by the erosion of underlying granitic rocks at Moss Beach, was processed by two major companies who operated adjoining plants in the area. The Del Monte Properties Company, owner of the entire dune deposit covering about 12 square miles, produced high quality white sand for the foundry, plastering, stucco, and glass industries throughout the Pacific Coast.

At the Owens Illinois plant, dune sand containing about 45 percent feldspar was moved by a Caterpillar bulldozer to a field hopper feeding an 1800-foot field conveyor. Sand from the surge pile was classified, washed, drained, kiln-dried, and conveyed to Dings magnetic-belt separators, where the ''black minerals'' or magnetic fraction of the sand was removed. These minerals included biotite, ilmenite, garnet, and zircon; the original iron oxide content of 0.15 percent was reduced to 0.07 percent. This product was easily blended with lime and soda ash in the manufacture of container glass, without physical segregation in the batch, at the company's Oakland plant. F.F.D.

Napa County

Pumice was mined on the east side of the Napa Valley along Highway 37 where the lightweight material occurs as a tuff in the Sonoma volcanics. Perlite produced east of St. Helena was processed at two plants, one located in the county and the other located at Campbell, Santa Clara County. Substantial quantities of basalt were quarried at Napa and gravel was produced at St. Helena, Oakville, and Pope Valley.

Nonmetallic Industrial Materials. The National Perlite Company produced crude perlite from their property on the Holt Ranch in the southeast quarter of sec. 33, T. 8 N., R. 5 W., until April 1949. The deposit is free from overburden and weathering of the perlite extends only a few inches from the surface. Vertical jointing is prominent in the 30 by 50-foot quarry face. Blocks of pumice about 2 feet square were blasted out of the face and then broken into 6-inch material which was trucked to the company's expanding plant at Campbell, near San Jose.

The St. Helena Perlite Aggregates Company began quarrying crude perlite in the N$\frac{1}{2}$ sec. 34, T. 8 N., R. 5 W., M.D. A Dant and Russell-type inclined rotary furnace about 24 inches by 20 feet in size was installed on the A. J. Almeida Ranch in Conn Valley to expand the crude rock. Perlite at the surface of the deposit contained a minimum of 2$\frac{1}{2}$ percent water. Production at this property started in April 1950.

The principal pumice operation in the county was conducted by the Basalt Rock Company at their Mount George deposit. The deposit occupies a hill adjoining the highway. The entrance level was semicircular to permit truck loading and maneuvering. The vertical face rose about 50 feet above the floor of the level, and was equipped with a truck-loading bin. The upper level was semi-bowl shaped, and consisted of a floor about 200 feet wide, merging into a wall, which extended 300 feet eastward and upward at an angle of about 30°. A pair of Caterpillar-diesel D-8 scrapers started excavating at the east edge of the bowl, and working side by side proceeded in a southwesterly direction, their blades loosening and accumulating a load of pumice, which was delivered to the truck-loading bin at the west edge. When the surface pumice was wet and soggy, it was loosened and fragmented with a rooter. The crude pumice was processed by grinding in hammer mills, washing with high-pressure water sprays to remove the clay, and screening. The final product was plus eight mesh to minus $\frac{5}{16}$-inch in size. This pumice was used in ''Strescrete'' as well as in the conventional light-weight building blocks. ''Strescrete,'' a slab system for roof and floor construction, utilized machine-made units of either light or heavyweight concrete and pre-stressed steel.

Frederickson Brothers of Emeryville were mining pumice from the Pearl quarry on Highway 37 in April 1950. The quarry consisted of two benches, each about 30 feet high. The pumice was removed by a 2-yard diesel shovel, assisted by a bulldozer. This crude pumice passed a high-compaction test, and was used as a base for the state highway then under construction west of Napa.

Substantial quantities of crushed rock were produced at the Basalt Rock Company quarry, and Juarez quarry in the Napa vicinity. At the former quarry, fragmented basalt was sorted by either a 3- or 5-yard shovel. The rock was reduced by a primary jaw-crusher and secondary gyratory crushers, after which it was screened and dropped to the underlying bunkers. For fulfillment of breakwater contracts, cap rock and face rock were trucked to the Napa river, transferred to 1000-ton barges by crane, and shipped to the delivery point.

Sand and gravel was produced by the McGill Rock and Sand Company on Conn Creek, about 1½ miles east of Oakville; at the Smith gravel pit on Sulfur Creek, on the southwest edge of St. Helena; and at the Benson gravel pit located near Whiterock on Pope Creek, about 5 miles east of the Pope Valley store.

R. A. Wheeler, Box 204, Angwin, made pink-colored building blocks from furnace sinter at the Etna quicksilver mine dump. The sinter was crushed to minus one-half inch size, screened, mixed in a cement mixer, and poured into molds.

F.F.D.

Nevada County

Gold mining continued as the most important mining activity in Nevada County, the leading county of California in production of lode gold, as well as in total gold production during 1949. However, the rising wage scale and increased cost of materials, combined with the fixed price of gold, has resulted in a great reduction of activity in recent years. Most of the mines are shut down, and those which have remained open were operating on a reduced scale. Other minerals produced in Nevada County during 1949 were silver, lead, crushed rock, and building stone.

Nonmetallic Industrial Materials. The Twin City Gravel Company of Nevada City produced crushed rock from the old California mine dump and from the Shady Creek gravel deposit for use in street and road construction in the area. This company also produced building stone from white quartz boulders which were obtained from old hydraulic pits.

Metals. The two largest gold mining operations were conducted by the Empire Star Mines Co., Ltd., and the Idaho-Maryland Mines Corporation, at Grass Valley. Owing to adverse economic conditions these organizations at present use the block-leasing system for extracting ore, a method whereby sections of the mines are leased to experienced miners.

Activities of the Empire Star Mines Co., Ltd., involved approximately 125 leasers and over 200 company employees. Ore from the company's Empire, North Star, and Pennsylvania mines at Grass Valley, and the Brown Valley properties in Yuba County, was treated by amalgamation and cyanidation. Silver is associated with the gold. The company also milled and cyanided ore and concentrates from other mines in the district. The mill and cyanide plant is rated at 500 tons per day and the mill production averaged approximately 110 tons of ore per shift.

Idaho-Maryland Mines Corporation operated two mines at Grass Valley throughout 1949; approximately 35 leasers worked in the Idaho mine and 85 in the Brunswick unit. Gold ore was treated by amalgamation, followed by cyanidation of concentrates. A total of 210,152 tons of ore was treated during the year, compared to 213,605 tons during 1948. However, a higher yield in gold per ton in 1949 resulted in a greater return. Metallurgical recovery of gold was stated to be 95.6 percent. Silver was also recovered from the ore in a weight proportion of approximately a fourth that of the gold.

Ancho Erie Mining Company operated the Ancho and Erie mines near Graniteville. A total of 2600 tons of ore from the Erie unit was treated at the 200-ton concentrating mill and 6-ton cyanide plant. The 4 D's mine near Graniteville worked from June to October. A small quantity of high grade ore was amalgamated yielding gold and silver. The lower grade ore was treated at a custom cyanide mill. The Stockton Hill mine, south of Grass Valley, shipped gold ore to a custom cyanide mill. The Washington Creek (Giant King) mine was operated by Dallas Church. The ore was trucked to a custom mill for cyanidation. At the Howie drift mine a vertical 2-compartment shaft was sunk 230 feet to bedrock. New machinery was installed and production was expected to begin early in 1950.

Several hydraulic mines in the Washington district operated during the spring wet season. These hydraulic operations included those of A. P. Landsburg and Joe Swazey at the Relief Hill mine, Frank Mellott at the Waukashau mine, Goldfield Consolidated Mines Company at the Omega mine, and Harry Murray at a claim near Moores Flat. Crescent Pacific Mining Company operated the Eastman placer deposit throughout 1949, using draglines and a washing plant. Many small-scale placer operators, included snipers, worked sporadically throughout the year. S.J.R.

Orange County

Orange ranked fourth among the counties of the state in value of annual mineral production, owing to the extensive development of the petroleum and natural gas industry in this area. Shells and salt from upper Newport Bay, clay from numerous pits and an underground mine, sand and gravel produced chiefly in the Santa Ana-Orange area, and peat humus from a bog at Huntington Beach contributed to the county's production of mineral raw materials. A Santa Ana battery plant used lead ore from the company's mine in Inyo County.

Mineral Fuels. Nearly all of Orange County's recorded mineral production has been oil and gas from the oil fields in the northern and southwest portions of the county.

The oil and gas production of Orange County for 1949 was 37,208,627 barrels of oil and 31,402,921 thousand cubic feet of gas.

No new fields or discoveries were made in Orange County during 1949, but drilling continued throughout the year. During 1949 there were 173 new wells completed, totaling 880,342 feet of hole, and 25 dry holes, totaling 131,629 feet.

Nonmetallic Industrial Materials. Shellmaker, Inc., produced crushed shells on the east side of upper Newport Bay. Two suction dredges, equipped with 10-inch and 6-inch suction pumps, delivered the dredgings to a plant on the shore where the shells were washed free of silt in a revolving screen. The clean shells, after being dried in an oil-fired rotary kiln, were crushed with rolls and separated into three sizes.

The operation of the Irvine Salt Company on the east side of upper Newport Bay was purchased by the Western Salt Company on January 1, 1950. Unrefined salt produced by solar evaporation was sold for use in water softeners, steel mills, laundries, and for brine used by fishing boats. The bittern was used in weed killers and dust settlers.

Peat humus was produced by three operators from a bog near Huntington Beach. Operations of Price's Peat Humus Company were typical. Peat from a bed that ranges from 4 to 32 feet thick was excavated with a clam shell and hauled to the drying area where it was spread and dried by aeration. The dried peat humus was ground. Nurseries, fruit growers, and vegetable growers were the principal consumers of this material.

The El Toro Clay Company operated two clay pits, the Robinson and the Serrano, in Trabuco Canyon approximately 12 miles east of El Toro. In July 1950 a third deposit was opened on the nearby Hunter Ranch, where future operations will be conducted. Material from these pits is a mixture of kaolin and quartz sand, the best grade of which averaged about 40 percent kaolin. Crushed ore with no additional processing is marketed as ''gannister''. Clay, considered by the ceramic industry to be a high-grade kaolin type, was produced by carefully washing the raw material at plants on the Robinson Ranch and in Los Alisos Canyon. Since early in March 1949, W. A. Shoeppe has been grinding the quartz sand reject from the Los Alisos plant for sale as a high quality silica sand.

Gladding, McBean and Company carried out development work at their Claymont property, an underground mine whose output is a high grade fire clay used for ladle brick. The work included the driving of a new tunnel which was approximately 800 feet long at the end of the year, and the construction of a 1150-foot aerial tramway from the mine to newly installed bunkers. Clay was trammed from the mine in 3-ton cars, lowered on the tramway to the bunkers, dumped, and later hauled away by truck.

In April 1949 the Liston Brick Company started producing building brick at their plant 6 miles southeast of Corona on State Highway 71. Clay was obtained from three deposits near the plant. The Mission Clay Products Company at Orange obtained clay from the bottom of a reservoir leased from the Santa Ana Valley Irrigation Company at periods when the reservoir was dry. Products were floor tile, roofing tile, and adobular brick. Clay for the floor and roofing tiles was ground, shaped in a brick machine, dried on shelves from 2 to 3 weeks, and fired. Adobular brick was shaped by hand, dried in an open field, and fired.

Sand and gravel producers operated at full capacity. The largest number of active producers was in the Santa Ana-Orange area, but production also came from properties at Anaheim, Fullerton, San Juan Capistrano, Seal Beach, Buena Park, and El Modena.

Metals. The Lippincott Lead Company at Santa Ana processed lead ore for use in making batteries. Most of the ore, which contained high silver values, was from the company's mine near Ubehebe Peak, Inyo County, and was used in the manufacture of high quality battery grids.

A 150-foot tunnel was driven on the Alma vein of the Wilbunt mine in Santiago Canyon about 9 miles northeast of El Toro. Ore from the deposit contains silver, lead, and zinc. J.W.C.

Placer County

Mineral production in Placer County during 1949 consisted of raw clay, dimension stone, sand and gravel, crushed rock, gold, and silver. The extensive clay pits and processing plant at Lincoln are the most important part of the county's mineral industry.

Nonmetallic Industrial Materials. Gladding, McBean and Company produced raw clay from the Mine and Mill, Towle, and Atkinson pits at Lincoln; the Mine and Mill unit was the most active during 1949. These pits are located in dark-brown to white-colored clay of the Ione formation. Fifteen to 20 feet of overburden, principally andesitic agglomerate, was broken by blasting and removed by power shovel in order to mine the clay by open pit methods. The properties of the stratified clay vary from layer to layer and consequently it was mined selectively. Operations were conducted only during the dry season. The clay was broken with rooters and loaded into trucks with power shovels. A portion of the mined clay was trucked to the plant at Lincoln, where it was utilized by the company in manufacture of ceramic products. The remainder was hauled to the mill at the Mine and Mill pit, where it was stock piled and sacked for sale as raw clay. At Gladding, McBean and Company's plant in Lincoln the clay was mixed with other raw clays and manufactured into such products as architectural terra cotta, face brick, roofing tile, sewer pipe, and chimney pipe. Approximately 600 persons are employed in the mines, mill, and plant at Lincoln.

Lincoln Clay Products Company continued operation of its pit at Lincoln, mining clay throughout the dry season. This company does not manufacture ceramic products, but sells its entire output as raw clay. The mined clay was run through a 2-inch Williams single-roll crusher, and conveyed from the pit to railroad storage bins. Several grades of clay were gravity loaded into freight cars. The clay was sold largely in carload lots; however, a small percentage of the output was ground and sacked for sale in smaller lots.

Union Granite Company produced dimension stone from two quarries in Placer County. ''White granite'' was quarried at Rocklin; and gabbro, sold as ''black granite'', was obtained from a quarry 2 miles east of Loomis. The rock was drilled and blasted into large blocks, which were trucked to the finishing plant at Rocklin. Here, they were sawed into slabs of desired dimensions, and polished and otherwise finished to meet customer requirements. Production during 1949 included approximately 8,000 cubic feet of finished stone, principally cemetery monuments, and 2,000 tons of other monumental stone, building stone, fireplace stone, riprap, and waste.

Marshall and Miles Gravel Company produced crushed rock on the Bear River a few miles east of Colfax. The river gravel was removed by a slack-line cableway equipped with a 2-yard bucket. Size reduction was made by a primary jaw crusher and a secondary cone crusher. The production, 12,000 to 15,000 cubic yards per month, was sold largely for cement aggregate. Bear River Sand and Gravel Company, adjoining the Marshall and Miles property, also produced crushed rock primarily for use as concrete aggregate. In addition, these companies sold boulders and cobbles for use as building stone.

Metals. The Mary Len mine, a lode gold property at Penryn, was active during the year. Gold ore was amalgamated and concentrated in the 25-ton mill, and concentrates were shipped to a custom cyanide plant. A total of 581 tons of ore was treated during 1949 for the recovery of gold and silver.

Schwartz and Mitchell operated a dragline dredge in Auburn Ravine. Bean and Armstrong Mining Company ground-sluiced at Canada Hill, using a bulldozer for excavating the gravel. Sporadic production by many small placer operators, including snipers, was reported from Forest Hill, Michigan Bluff, Iowa Hill, Bear River, Dutch Flat, and the Last Chance district. S.J.R.

Plumas County

Barite for oil-well drilling mud was mined near Almanor Dam. Gold was recovered from shallow gravel deposits near the head of Rush Creek. Manganese ore was mined in open cuts and shipped from properties near Almanor Dam and Crescent Mills.

Nonmetallic Industrial Materials. The Cameron barite mine in the Ohio Valley, about 3 miles south of Almanor Dam, was operated from April to August. Dark gray-colored barite occurs as a 4- to 6-foot wide lens in slate, and has been mined by an open cut 12 feet wide, 8 feet deep, and 100 feet long. The ore is pushed into a truck-loading hopper by a bulldozer and transported to consumers for use in heavy drilling mud.

Metals. Placer gold was recovered from the shallow gravel deposits near the head of Rush Creek by Francis Schultz and associates. The gravel was 6 to 14 inches thick above yellow clay and included pebbles and cobbles of quartzite, jasper, sandstone, and white quartz. The sands included some chromite and magnetite. Mining was done by clearing the surface of forest litter with a hand slip and loading the gravel into trucks with a quarter-yard power shovel or by hand shoveling. The gold, largely coarse, was recovered in a washing plant on the Come-back claim. Here the trucks dumped the gravel into a hopper from which it was washed through sluice boxes fitted with cast-iron riffles. Minus one-quarter-inch material dropped into the undercurrent and flowed to a side-shaking sluice 24 inches wide and 10 feet long fitted with steel riffles. Water for the plant was pumped from a pond on Rush Creek. Because of the heavy snowfall, the placer was worked only during the summer months. The search was continued for a faulted segment of the Rush Creek channel on the Sara claim. A new adit was driven 80 feet through rock slough in a direction S. 85° E., from a point about an eighth of a mile south of the discovery adit. Loose rock moved by a bulldozer from the hill above the adit included some gold-bearing float. The adit will be driven farther into the hill and raises run at intervals in search of the channel.

Manganese ore was shipped from the Sunset group of claims located in the mountains about three airline miles southeast of Almanor Dam. Psilomelane and some pyrolusite associated with red chert occurs in small lenses and nodules in black shale. The principal work was done on the Sunset No. 3 claim where the surface was stripped over a circular area about 300 feet in diameter. The manganese was mined from a T-shaped trench 125 feet long, capped by a trench extending 50 feet northeast and 15 feet southwest, which followed a contact with soft gray shale. The trenches were dug with a bulldozer to an average depth of 12 feet and the manganese ore was sorted from the shale. The material was shipped to Geneva, Utah, but the average manganese content was too low to mine and load on cars at Canyon Dam profitably at the price of 45 cents per unit of manganese. The operation was shut down January 7, 1950.

Manganese ore was shipped also from the Braito claims near Crescent Mills. Ore was mined from a vein 10 feet wide through an adit. Psilomelane and pyrolusite, associated with red chert between slate walls, were the principal ore minerals. A fault cut the vein and surface prospecting for the faulted segment was done by bulldozing. The property was closed in September 1949 when the price of 45 cents per unit for the ore proved unsatisfactory. J.C.O'B.

Riverside County

Shipments of iron ore from the Eagle Mountains reached a substantial figure during the year. Development work was in progress at gold mines in the Pinto Basin area, where two mills were erected. A small quantity of lead ore was mined and stock piled. Large quantities of nonmetallic minerals were produced as follows: low-iron glass sand at Corona, clay at Alberhill, gypsum at Midland, limestone and cement at Crestmore, and concrete aggregate at numerous points.

Mineral Fuels. No accumulations of petroleum have been found in Riverside County. In 1949 one well was drilled to 950 feet near Corona without favorable results.

Nonmetallic Industrial Materials. The Owens-Illinois Glass Company produced glass sand near Corona during the year and shipped almost all of it to their own plant in Los Angeles. A water shortage was alleviated by installation of two thickeners to reclaim process water for re-use. Products were flint glass sand averaging 0.035 percent iron and colored glass sand averaging 0.06 to 0.07 percent iron.

The Los Angeles Brick and Clay Products Company mined clay at Alberhill for making fire brick, flue lining, face brick, sewer pipe, roof tile, and hollow building tile. The company's high-grade fire clay was hand-sorted at the quarry and loaded with a skiploader. The lower grades of building clay were excavated with bulldozers and then loaded. The Alberhill Coal and Clay Company purchased a drill during the year and initiated a testing program that has revealed a number of types of clay differing from those being mined. Toward the end of the year the company's principal source of sewer pipe clay was exhausted and a new pit was opened. Shipments from the new deposit started about March 1, 1950. During the latter part of the year Gladding, McBean and Company started drilling and testing work at their Alberhill property. Stripping operations were begun February 13, 1950.

The Riverside Cement Company, one of the major producers of cement in California, continued to produce portland cement at their plant at Crestmore. The company's Crestmore mine, which produced limestone from underground workings for many years, has been inoperative for some time. The bulk of the limestone now being used is obtained from the old Jensen quarries located 3 miles west of Crestmore. The Riverside Cement Company also operates a plant at Oro Grande, San Bernardino County.

The United States Gypsum Company operated their Midland plant at peak capacity except for temporary curtailment in the early part of the year because of a slackening in demand for building materials. Gypsum came from extensive deposits of pre-Tertiary age in the Little Maria Mountains west of Midland. Both underground mines and open pits have been opened within 2 miles of the processing plant.

Sand and gravel plants at most of the larger towns produced a wide variety of aggregate and fill materials.

Metals. The Bald Eagle mine of the Kaiser Steel Corporation produced 618,898 tons of iron ore averaging 54 percent iron. Excavation was begun in June 1948, and the first ore was shipped October 13, 1948. The ore, a hard, abrasive hematite with lenses of magnetite, is a replacement of limestone and dolomite in a series of sediments metamorphosed by monzonite sills. Two irregular beds of ore dipping 40°-70° N.E. toward Bald Eagle summit had been traced for 8,000 feet along the strike. Thirty-foot benches were made by blasting a single row of holes drilled by three Bucyrus-Erie 29-T churn drills. Spaced 12 feet apart and 12 to 14 feet back from the top of the bank, the holes were loaded with ''Trojanit'' 70 percent bag powder, tied together with Primacord, and detonated with a single instantaneous electric cap. Three Ingersoll-Rand X-71 wagon drills using detachable bits were employed for drilling vertical clean-up holes and for the slope holes that were drilled on the line of the pit face. One Bucyrus-Erie 120-B electric shovel and two Bucyrus-Erie 54-B diesel shovels loaded ore and waste into a fleet of 14 Euclid 15-ton 9.7-cubic-yard Model FD trucks equipped with Parkersburg Hydrotarder braking devices. Shovel operators sorted ore and waste as the material was loaded into the trucks. Ore was dumped into a 50-cubic-yard hopper and fed with a 60-inch Stephens-Adamson pan feeder to a 48- by 60-inch Traylor jaw crusher set at 8 inches. A boom-stacker distributed the crushed ore on a stock pile over a reinforced concrete tunnel. Ore was drawn from a draw point in the tunnel and loaded into 60-ton railroad cars. A privately operated railroad 52 miles long connected the mine with the Southern Pacific Railroad's interchange yard at Ferrum.

The Pinto Basin area enjoyed considerable gold mining activity. During the year W. C. O'Connor, owner of the Sunrise, Mission, and Standard mines, was engaged in building a 100-ton custom cyanide mill, which will serve his three properties. Development work carried out at the Mission mine included a two-compartment shaft 600 feet deep, drifting on the 100, 300, 400, and 600-foot levels, and a raise from the 600-foot level to the surface. Five thousand to ten thousand tons of ore have been blocked out. At the Outlaw group, owned by W. P. O'Connor and J. P. Hayes, only assessment work and road work were done. Dale Holmes worked the Los Angeles mine and erected a 35-ton mill, which was operating in September 1950. Jigs and flotation cells were employed to recover the gold.

The Black Eagle lead mine was leased to W. E. Covey of Indio who worked the property intermittently. Development work consisted of 150 feet of drifts and raises and a small amount of stoping. Approximately 800 tons of ore were mined and stock piled. High-grade gold-copper ore encountered was not developed. During September and October a 1 ton per hour smelter was installed but did not operate satisfactorily because of the type of fluxing material used. J.W.C.

Sacramento County

The Rio Vista field was the largest producer of natural gas in the state. Although this field extends into Solano and Contra Costa Counties, most of the production came from Sacramento County. Excluding natural gas, gold dredges provided the major portion of the mineral production. The gold-bearing terrace deposits of the American and Cosumnes Rivers were mined by bucket-line dredges at several localities. Crude clay was mined and clay products were manufactured at Sacramento. Large quantities of sand, gravel, and crushed rock were produced from deposits along the American River near Fair Oaks, and from older terrace deposits near Perkins.

Mineral Fuels. Large quantities of natural gas were produced in the Rio Vista field. The gas was dry and consisted of methane with minor quantities of carbon dioxide and nitrogen. During the year 12 new wells were completed. One new well was completed at a depth of 3,350 feet in the Thornton gas field.

Nonmetallic Industrial Materials. The Sacramento Brick Company produced sandy clay from a pit on the Sacramento River, using a 2½-yard dragline. The clay was reduced by crushing rolls, tempered in pug mills, and molded into common sand-mold bricks. The molded bricks were steam-dried and fired in open-type field kilns. This was a seasonal operation.

Cannon and Company produced clay from a pit in North Sacramento and obtained additional crude clay from the Michigan Bar area. These clays were used to manufacture face brick, fire brick, hollow tile, floor tile, and other products.

The Fair Oaks plant of Pacific Coast Aggregates, Inc., mined and processed gravel occurring in bars along the course of the American River. Old dredge tailings within 1½ miles of the plant also provided raw material for crushed rock. The contents of a rock sample from this plant were 89.9 percent metamorphic and 10.1 percent igneous as determined by petrographic examination. A 2-yard dragline and a 2½-yard power shovel were used to dig the gravel which was hauled to the plant in 14-yard trailers and 10-yard "Mississippi wagons." Plant capacity was from 200 to 300 tons per hour.

Metals. The Natomas Company operated six bucket-line gold dredges on fee land in the Rancho Rio de los Americanos. Dredge No. 8, equipped with 104 twelve-cubic-foot buckets, typifies these operations. This dredge was able to maintain a 25- to 30-foot bank while digging under 68 feet of water. Some of the ground worked was 96 feet deep. The buckets discharged into a hopper ahead of a 9- by 60-foot trommel with ⅜- and ½-inch perforations. A 16-inch pump supplied the trommel with high pressure wash water through 1¼-inch nozzles. Oversized material was discharged to the tailings stacker. The undersize dropped into a distribution box which regulated the flow of pulp to a bank of eight 42 by 42-inch Pan-American jigs on each side of the trommel. Additional water was added to the jig overflow. Each jig overflowed onto two 21-inch double-deck sluices, equipped with iron-faced wooden riffles and mercury traps. The concentrate from each bank of jigs flowed over an amalgamating sluice. Rusty gold was recovered by routing this sluice discharge to a jig, a 3-foot pebble mill, and a final sluice with mercury traps. The total gold recovery was estimated to be 90 percent, and 85 percent of the total recovery was made in the jigs.

The General Dredging Company operated a dragline on Alder Creek south of Folsom and dredged over 1,000,000 yards of gravel. The dragline was equipped with a 2½-yard bucket on a 70-foot boom, and discharged to a floating wash-plant with a Bodinson pontoon hull. Gold was recovered by expanded metal riffles and mercury traps in sluices which flanked the 24-foot trommel. About one percent of the total recovery was in platinum values. The capacity of the dredge was approximately 200 yards per hour.

The Capitol Dredging Company operated two bucket-line dredges and the Lancha Plana Gold Dredging Company operated one bucket-line dredge part of the year. The Cosumnes Gold Dredging Company operated a bucket-line dredge on the terrace deposits south and east of the Cosumnes River. Placer gold was also recovered by the Mountain Gold Dredging Company in the Michigan Bar area. R.M.S.

San Benito County

Large quantities of cement rock were quarried and manufactured into cement at San Juan Bautista. Dolomite was mined at Hollister. Crushed rock was quarried and processed in a large plant at Logan. Quicksilver was produced at four mines in the New Idria district, although total output was below that of recent years. A small quantity of bentonite was produced. Exploratory drilling for oil proceeded at an active pace.

Nonmetallic Industrial Materials. Good quality dolomite was quarried in the La Cienega district 12 miles south of Hollister by the Westvaco Chemical Division of Food Machinery Corporation. The dolomite was shipped to the company's magnesia plant at Newark where it was calcined and used to process salt-plant bitterns in the manufacture of various magnesia products. This district has long been a producer of limestone and dolomite from lenses or roof pendants, which occur both in schistose and granitic country rock in the Gabilan Range. The dolomite at this quarry is a white, fine-grained material that runs about 22 percent MgO and is low in iron, silica, and alumina. It was mined from one of four 20-foot quarry faces by a caterpillar-mounted Northwest diesel shovel equipped with a 1-yard dipper. Since the quarry was in the San Andreas fault zone, the rock was fractured, broke readily, and was easily removed by the shovel. Careful chemical control of production was maintained by constant sampling of the working faces. The quarry operated 5 days per week on one 9-hour shift.

The San Juan Bautista plant of the Pacific Portland Cement Company was reopened in 1947 and has been operating continuously since that time. Natural cement rock for cement manufacture was mined at a quarry in San Juan Canyon about 8 miles from the plant. The deposit which was in the San Andreas fault zone, was so fractured that only occasional light shots in toeholes were required. A 2½-yard shovel was used to load quarried rock to 30-ton trucks. Benches with 100-foot faces were maintained. The crushing house was located at the mill site, where crude limestone was reduced to minus three-quarters-inch size by a gyratory crusher and a hammer mill, and was then conveyed to the mill stock pile. The cement mill included four gas-fired, counter-current, rotary kilns, having a 6-foot inside diameter, four underlying rotary coolers, tube mills for clinker grinding, and a battery of concrete storage silos 68 feet high. Shipments were by bag or bulk. The plant employed 131 men, including six men in the quarry, and has a rated capacity of 2500 barrels of cement per day.

A large quantity of crushed rock was produced at the Granite Rock Company's Logan quarry, one of the numerous quarries in the area located in the San Andreas fault zone. The fault, which crosses the north end of the property has so fractured the rock that blasting requirements were reduced. Quarry operations consisted of removal of overburden by hydraulicking when necessary, light blasting, shovel loading the quarry rock into railroad cars, and transportation to the adjoining crushing and screening plant for further processing.

Metals. The New Idria and Juniper mines were the principal quicksilver producers in 1949; a small production was also made at the Aurora and North Star mines. The rate of production at the New Idria mine was far below capacity. Here the size of the operating crew has been periodically reduced since the termination of World War II in 1945, owing to the continued decline in the price of quicksilver. By June 1950 the company had decided on a complete shut-down of the mine and was removing electric wires and track from the workings. Considerable ore of average grade remained on the tenth level, but it could not be profitably worked at prevailing prices.

At the Juniper mine, formerly the Lea-Grant, Henry Berg and Louis Sciochetti have continued to develop the property, which they began operating about 5 years ago. Current work was centered around the old Lily workings near the entrance to Griswold Canyon where ore occurs in hydrothermally altered Panoche sandstone on the north flank of the Ciervo anticline. Entrance to the workings was gained through two adits. The lower adit extended westward about 250 feet, and track was laid to the face. A number of raises extending to the upper level provided ventilation and permitted the transfer of ore to the lower level. The walls stand well, but timbering was used at a few places where the adit had been widened by removing ore. In places seams of cinnabar a quarter of an inch thick traversed the back and walls of the adit, and near the working face the roof was solid cinnabar. A considerable quantity of 3 percent ore has been mined. Operations were slightly handicapped by lack of water. The ore was hand-trammed to the portal of the lower level, dumped through a grizzly into the mine bunker, and trucked about a half a mile to the retorts. The latter consisted of two units, each containing two alloy-steel cylindrical rocket tubes, half an inch thick, 12 inches in diameter, and 12 feet long. F.F.D.

San Bernardino County

The production of nonmetallics in San Bernardino County during 1949 far exceeded that of metals, both in quantity and value. The largest mining operations in the county were those of the portland cement plants at Colton, Oro Grande, and Victorville, and of the heavy chemical plants that treat the Searles Lake brine. Talc, lime-rock, silica, clay, and calcium chloride contributed to the total nonmetallic output. Metal mining was hindered by uncertain metal prices and high operating costs. Lead, zinc, and tungsten were mined in the greatest quantity; but silver, copper, gold, and iron ore were produced also.

Mineral Fuels. During 1949, five dry holes totaling 14,506 feet were drilled in the Barstow, Cajon Pass, Chino Hills, and Victorville areas. Oil has been sought in San Bernardino County for many years, but with the exception of an area of small production near Chino, the exploration has been unsuccessful.

Nonmetallic Industrial Materials. The county's three portland cement plants, the California Portland Cement Company at Colton, the Southwestern Portland Cement Company at Victorville, and the Riverside Portland Cement Company at Oro Grande continued production at a high level.

By far the most important saline producing area is the Searles Lake district where the American Potash and Chemical Company at Trona continued to produce borax, boric acid, potassium sulfate, potassium chloride, sodium sulfate, soda ash, lithium salts, bromine sales, and bromine from the Searles Lake brine. The West End Chemical Company, also at Searles Lake, continued production of borax and soda ash from the same brines.

Common salt and calcium chloride were produced at Bristol Lake. The California Salt Company worked a 5-foot bed of rock salt that lay beneath 6 to 7 feet of overburden. After a dragline had removed the overburden, the salt was drilled with wagon drills, blasted, and loaded into small cars by draglines. At the mill at Saltus, 4 miles from the deposit, the salt was crushed to 2 inches, washed on conveyors, crushed again to minus three-fourths inch, and rewashed on a set of spiral conveyors that discharged directly into gondolas. Approximately half of the output was consumed by the Los Angeles Metropolitan Water District and the remainder by the Stauffer Chemical Company at Henderson, Nevada. Capacity of the plant was 50 to 60 tons per hour. The Hill Brothers Chemical Company produced flake calcium chloride at Saltus from brine obtained from the California Salt Company. M. M. Stevens of Amboy also produced calcium chloride. Lake brine that seeped into a collecting ditch was pumped into evaporation ponds where it was concentrated to a gravity of over 40° Baumé (over 50 percent evaporation). At this density sodium chloride precipitated, with calcium chloride remaining in solution. The calcium chloride brine was pumped into storage tanks and shipped in tank trucks. A flaking plant owned by Mr. Stevens has been inactive since 1948. The sodium sulfate plant of the Dale Chemical Industries, Incorporated, at Dale Lake was shut down in February 1949, and no shipments were made.

The Victorville Lime Rock Company produced a wide range of sizes of ground limestone at Victorville. Two grades of rock were produced from the same quarry 4 miles north of the plant. One, a very white material selected by hand picking, was used in paint and putty, while the other, which is slightly off-color, was used in ceramics, stucco, plaster, stock feed, for roofing granules, and in the ceramic, rubber, and foundry industries. The mill, which employed a process of dry crushing and air classification, ran 24 hours a day throughout the year. The Chubbuck Lime Company opened a new quarry late in 1949 half a mile from Chubbuck. Crushed limestone was produced.

W. H. Johnson and Company produced granite for building stone at a fabricating and polishing plant in Victorville. Although the company quarried a little stone from its own properties, most of the stone processed came from California localities outside of San Bernardino County, other sources in the United States, or from foreign countries, notably Sweden. Some stone came from the company's Lucerne Valley property where three quarries had been opened. Three deposits of different colored stone near Baker and a newly discovered deposit of green granite at Stoddard wells were being developed. At the Victorville plant granite was sawed into 1- to 6-inch slabs, plastered to polishing beds for preliminary polishing, shaped with diamond saws, and given the final polish.

The Atlas Silica Quarry made large shipments of various grades of crushed and screened silica and quartzite from a plant and quarry about 3 miles east of Oro Grande. The operation, which was owned by the Mineral Materials Company of Alhambra, California, began production in 1939. The material was used as a refractory and in the manufacture of sulfate-resistant cements.

The Baroid Sales Division of the National Lead Company produced bentonite from the Hector mines 4 miles south of Hector. Although in the past bentonite had been obtained from an open pit, all of the 1949 operations were underground. The material was trucked to Hector, sun-dried, and shipped by rail to the company's grinding plant at Los Angeles. Most of the output was used in the manufacture of drilling muds. The Inerto Company of San Francisco also produced bentonite from an underground mine close to the Hector property. Hand-picked, high-grade bentonite was used by the Inerto Company for filtering beer; the remainder was sold for numerous other purposes. The clay deposits near Hart were worked by Gladding, McBean and Company of Los Angeles and by the Southern California Minerals Company. Clay from these open cut operations was used mainly in the production of wall tile.

The four talc producers that had been active in previous years mined talc primarily for the ceramic industry, although a substantial tonnage was consumed by the paint, rubber, and textile industries. The largest single talc operation in the county was the Western mine several miles southeast of Tecopa which has been operated by the Western Talc Company for many years. The Pomona Tile Company worked its deposit near Yucca Grove, while the Southern California Minerals Company whose talc operations are centered about an area north of Saratoga Spring, worked the Superior mine continuously and put the Pongo mine into production. The Sierra Talc and Clay Company mined talc throughout the year at the Silver Lake mine northwest of Baker and at the Ibex and Monarch mines near Ibex Springs. This company also operated the Smith mine in the western Kingston Mountains during the early part of the year.

Bastnäsite. One of the most significant mineral discoveries in the state was made in April 1949 when bastnäsite was discovered near Mountain Pass, about 33 miles east of Baker, immediately north of U. S. Highway 91. Bastnäsite is a fluocarbonate of cerium and lanthanum, with minor amounts of thorium and uranium present as impurities. The uranium and thorium content is apparently too small to allow the deposits to be worked for these elements, but is sufficient to impart radioactivity to the mineral. However, up to the present, most of the rare-earth elements used in the United States have been obtained from monazite, which is largely imported. The discovery is therefore of economic importance as it may serve to make the United States independent of foreign sources of these elements.

Geologists of the U. S. Geological Survey assigned to map the deposits discovered that the bastnäsite occurs in carbonate veins, which also contain barite, fluorite, quartz, limonite and hematite, and a small amount of galena. The veins of the discovery area are contained in shonkinite, a plutonic rock closely related to syenite. The shonkinite has intruded pre-Cambrian schists and gneisses. In this area at least five veins containing bastnäsite are known, and a shallow shaft on the largest exposed a 15-foot vein containing 20 to 30 percent bastnäsite. The veins also contain other rare-earth minerals, including at least one previously undescribed species. Since the discovery, veins have been discovered at other localities through a belt at least 6 miles long. Most of these are contained in pre-Cambrian gneisses and schists rather than in the shonkinite. At the end of 1949, arrangements were being made for the Molybdenum Corporation of America to purchase and develop the original sixteen claims. In the surrounding territory many prospectors have been active staking and developing other claims.

Metals. The Mohawk mine at Clark Mountain, the principal lead producer of the county, made shipments during the first half of 1949. Because of a drop in the price of lead, operations were curtailed after June and the crew reduced to two men; the mine was closed at the end of the year. The ore was principally lead and zinc carbonates carrying silver. Development work was restricted to 800 to 900 feet of diamond drilling on the 256-foot level of the Winter Quarters winze. Reserves of relatively low-grade ore were reported to be large. The Carbonate King zinc mine on Kokoweef Mountain shipped ore averaging nearly 40 percent zinc to the International Smelting and Refining Company at Tooele, Utah. The principal ore minerals were smithsonite, hydrozincite, and sphalerite. A small amount of diamond drilling was done, and a winze was sunk 100 feet during the year. Ore was found after crosscutting 20 feet from the bottom of the winze. The New Trail copper mine in the Ivanpah Mountains was leased by the Alloy Mining Company in October 1949. Small shipments of copper-gold ore were made in the first half of the year. The Roosevelt (Bagdad-Chase, Pacific) mine produced copper-gold ore, mainly from the 400-foot level of the inclined shaft. Little development work was undertaken. From four to six men were employed throughout the year. The California Silver Corporation built a 50-ton mill at Silver Lake, 7 miles north of Baker, to process ore from the company's Silver Hill mine which was 12 miles from Silver Lake near Riggs. The new mill operated about 4 weeks and then was shut down. Concentrates were shipped to the American Smelting and Refining Company at Selby.

Shipments of iron ore were made from the Cave Canyon deposit to the California Portland Cement Company for use in the manufacture of portland cement. The California Portland Cement Company, which owns the deposit, contracted the mining and loading of the ore to the Mineral

Materials Company of Alhambra. The deposit has been worked about every 2 years to maintain a stock pile at the Colton plant. At the Bessemer iron mine, 8 miles southeast of Newberry, experimental work was carried out to determine the best method of mining the ore. Intermittent shipments were made to several foundries and steel mills, some as far away as Oregon and Washington.

The Surcease Mining Company of Sacramento, California, produced scheelite from lodes and scheelite and gold from placers at Atolia. Lode operations by the company were restricted to open pit mining with draglines, but underground lode mining was carried on by lessees. A semi-portable plant treated the placer ore. Gravel excavated with a dragline was washed and screened into three sizes with a trommel. The two coarsest sizes were hand picked under ultra-violet light, while the finest size was treated with jigs. Gold was recovered with two Ainlay bowls fed with mercury at the rate of 10 milligrams per hour. Plant capacity, which was influenced by the grade of the feed, averaged about 80 cubic yards per hour. Three shifts per day were working on draglines and two on the placer concentrating plant until the middle of the year when but one shift per day was employed on all operations. G.C.H.

San Diego County

In 1949 the entire mineral output of San Diego County was composed of nonmetallic industrial materials. The county has yet to yield petroleum in commercial quantities, and metal mining was dormant during the year. As in past years, salt and aggregate materials continued to be the county's principal mineral commodities. Also active were operations producing clays for use in the manufacture of brick and hollow building tile, crushed rock for poultry grit, granite dimension stone, magnesium compounds, pebbles for filters, pyrophyllite as an insecticide carrier, and sands for use in glass manufacture, sand blasting, and foundries. The total mineral yield for the year was valued at slightly more than $5,000,000.

Mineral Fuels. Although commercial accumulations of oil have been sought in the county for many years, none has been found. The only well drilled in 1949 is near Oceanside. It was abandoned at a depth of 1,028 feet when no oil showings were encountered.

Nonmetallic Industrial Materials. All of the salt produced in San Diego County is obtained at the plant of the Western Salt Company in Palm City, where sea water is subjected to solar evaporation. The sea water is first introduced into tide ponds, then successively transferred to evaporating ponds, pickling ponds and crystallizing ponds. Gypsum, magnesium salts and other materials are deposited in the pickling ponds; relatively pure salt forms in the crystallizing ponds. The remaining brine, known as bittern water, is delivered to the nearby plant of the Westvaco Chlorine Products Company where it is used in the production of various salts of magnesium and calcium. The salt at the Western Salt Company's plant is harvested during the summer months. It is loaded by a dragline into gondola cars and is used principally as a preservative for foods and hides, and in refrigeration and water softening processes.

The production of sand and gravel, in meeting the demands of the building and construction industries in San Diego County, continued at a high rate. Twenty-four sand and gravel pits were active in 1949. Most of these are along the San Diego, Sweetwater, Otay, and Los Penasquitos Rivers. Several of the relatively large operations center about the Mission Valley area. These include pits operated by the Canyon Rock Company, Caudell and Johnson, and the H. A. Fenton Material Company. Among the other principal sand and gravel sources is a pit at Poway operated by Caudell and Johnson, pits in Murray Canyon, Chollas Valley, and the Otay area operated by the H. A. Fenton Material Company, and a pit near Otay operated by Nelson and Sloan.

Specially processed sand, used mainly in stucco and plaster, but also marketed as a sand blasting or filter material, is produced by the Crystal Silica Company at Oceanside. The sand is removed from large open cuts. After its moisture is removed by heating, it is classified by screening and sold in numerous size grades.

Foundry sand, which for many years has been quarried at a locality within the San Diego city limits, continued to be produced in 1949. The quarry is operated by the Hubbard Molding Sand Company, and the sand is marketed throughout California for use in the manufacture of low-temperature castings.

Common brick and various types of pipe and tile were manufactured in three plants in San Diego County during 1949. These are the La Jolla Canyon Clay Products Company near La Jolla, the Union Brick Company in Rose Canyon, and the Vitrified Products Company in Linda Vista. The raw materials for these plants are obtained from nearby clay deposits. In recent years the county's brick and tile industry has installed much modern equipment, including extrusion-type brickmaking machinery and mechanized equipment for handling the raw materials and finished product.

The quarrying of granitic rocks as dimension stone, which for many years has been one of San Diego County's best known mineral industries, was continued at seven operations during 1949. Three companies, the Crystal and Black Granite Company, the Pacific Cut Stone and Granite Company, and the Valley Granite Company, worked quarries in the Spooks Canyon area near Escondido. The California Black Granite Company and the Clemens Granite Company operated quarries in Twin Oaks Valley near Vista and in the Suncrest area, respectively. Quarries near Pala and Vista were operated by Emil Johnson and Sons.

All but the Suncrest quarry yield black granitic rock known as gabbro. Although never mined in large volume, the rock is widely used as a dimension stone for monuments and the ornamentation of buildings. Most of the gabbro quarried to date has been obtained from large residual boulders. Each boulder must be worked separately. It is first split by drilling and blasting, and is broken into smaller blocks by the "plug and feather" method. The blocks are then shipped to finishing shops.

Crushed granite is marketed for use as insoluble poultry grit by the Ramona Granite Company of Pomona. The rock is quarried near Ramona and is marketed in both the Los Angeles and San Diego areas.

In the San Dieguito Canyon area is one of the few commercial concentrations of pyrophyllite in western North America. This deposit has been in operation for about 10 years and is worked by the Pioneer Pyrophyllite Products Company. The material is mined in an open cut, is dry-ground, and is marketed as an insecticide carrier.

Pebbles concentrated along some of the beaches in San Diego County were formerly gathered for use in ball mills. This market no longer exists, but the pebbles are now used in large water filtering systems. Several large city plants which replaced their materials in 1949 used these pebbles and brought an increase in their output.

Metals. Although no metal production was reported in San Diego County during 1949, early in 1950 a tungsten property, 8 miles south of Julian, was put into production. The mine is operated by the Live Oak Mining Company, which ships concentrates to a firm in Azusa. To date this operation has been on a relatively small scale. L.A.W.

San Francisco County

The small area and intense urban development preclude the establishing of extensive or diversified mineral production in this county. Nevertheless, sand, fill rock, mineral water, and a small quantity of placer gold were produced during the year.

Nonmetallic Industrial Materials. Sand bunkers near 41st Avenue and Pacheco Street in San Francisco, supplied from nearby sand dunes, market sand used as aggregate and fill. Mineral water was produced from a spring in the Mission district for use in beverages. Building contractors quarried ''red rock'' for fill from several places in the county, particularly in the Twin Peaks area of San Francisco.

Metals. Gold was produced by hand methods, using portable equipment, from black sand deposits which occur periodically on the ocean beach between Fleishhacker Zoo in San Francisco and San Mateo County line. One miner used amalgamation plates to recover the gold. These plates were mounted in a sloping sluice box about 3 feet long; the sluice box being held in a light, wood framework, which also supported a small hopper for the black sand, and a 5-gallon can holding the wash water. Jets of water from a pipe connected to the bottom of the water container washed the black sand through a slot in the bottom of the hopper and over the amalgamation plates. The necessary water for this operation was bailed from the surf. The amalgam was scraped from the plates with a razor blade. Sufficient gold was recovered in this manner to attract part-time workers during clement weather. J.W.V.

San Joaquin County

Gold was produced by a bucketline dredge near Clement and the tailings were leased to rock plants in that area. A large rock plant at Kerlinger processed a deposit of sand and gravel derived largely from the Franciscan formation. Sand and gravel products were also produced in the vicinity of Escalon and Riverbank. Lightweight building blocks were manufactured near Stockton, from pumice from Napa County. The clay products industry was centered in the Stockton area where common clay was mined. A substantial quantity of natural gas was produced at the McDonald Island field.

Mineral Fuels. Natural gas was produced from several fields in the county. The McDonald Island field near Stockton is the second most important gas field in northern California. Four producing wells totalling 21,119 feet in depth were completed by the Standard Oil Company in this field. Standard Oil Company also drilled a deep test hole here to 8,810 feet. The Amerada Petroleum Corporation drilled a deep test in the Tracy field to 9,690 feet.

Industrial Nonmetallic Materials. The Stockton Building Materials Company produced common sand-mold bricks in their plant on Roberts Island; clay was dug from a nearby pit. The bricks were air-dried and then burned in a Hoffman 16-section coal-fired continuous kiln.

The Stockton Brick and Tile Company produced face brick, common brick, and drain tile or hollow tile. Approximately two-thirds of their total clay requirements were filled from the pit at the plant which produced common red-burning clay. The remainder of the clay required was purchased from the Lincoln Clay Products, Placer County. The ''stiff-mud'' process was used for all products. Blended clays were tempered in a pug mill and discharged to the extruder. The shapes were wire cut to standard lengths and air-dried for 4 days prior to firing in a Hoffman 16-section continuous kiln. Each section of the kiln was coal-fired for about 24 hours, with the waste heat from the fired section preheating the ware in the other sections.

The Pacific Clay Products Company plant produced sewer pipe, drain tile, clay conduit, etc., but utilized clay produced in Calaveras County.

Steam-cured, lightweight pumice blocks were manufactured by the Basalt Rock Company at their ''Basalite'' plant south of Stockton. The pumice came from a company-owned deposit in Napa County, but sand for the aggregate was purchased from a producer near Escalon.

The modern plant of the Pacific Coast Aggregates, Inc., at Kerlinger, 4 miles south of Tracy, produced sand, gravel, and crushed rock. A petrographic report by the U. S. Bureau of Reclamation indicated that the rock types occurring in the gravel at this locality were approximately as follows: metagraywacke, 50 to 75 percent; veinlet quartz, 10 to 15 percent; chert, 10 to 15 percent; metabasic igneous rock, 5 to 10 percent; andesite, 5 to 10 percent; sandstone, 1 to 5 percent; and quartzitic metamorphics and schist, 1 percent each. It is interesting to note that the metagraywacke, veinlet quartz, and chert were all derived from the Franciscan formation and accounted for most of the material. This large deposit, which has been tested to a depth of 100 feet, was mined by carryall-type scrapers dumping into a 20-yard portable field hopper.

All of the tailings from dredging operations on the Mokelumne River were contracted for by several sand, gravel, and crushed rock plants in the area. The largest of these plants was that of Claude C. Wood Gravel Company, which operated several miles upstream from Clement. The Mokelumne Gravel Pit and the Clement Gravel Company also produced aggregate from dredge tailings.

Metals. The Lower Comanche dredge of the Gold Hill Dredging Company operated on the Mokelumne River just south of the Clement bridge. The digging ladder carried seventy-seven 9-cubic foot buckets which discharged into a 60-foot trommel. The dredge was capable of digging to a depth of 40 feet, although the depth of ground being worked ranged from 29 to 31 feet. Gold was recovered in 10 placer type 42 by 42-inch Pan-American jigs which overflowed into riffles. This jig concentrate passed to four 28 by 28-inch cleaner jigs discharging into a Titan amalgamator in closed circuit with two 14 by 14-inch scavenger jigs. A ball mill was used to clean rusty gold. The Upper Comanche dredge of the same company operated north of the Clement bridge for a portion of the year.

R.M.S.

San Luis Obispo County

The value of oil produced from Cuyama Valley now exceeds the total annual value of all other mineral commodities. Aggregate requirements are provided by a sand and gravel plant near Atascadero. Clay for common brick was produced at San Luis Obispo.

Mineral Fuels. Prior to the discovery of oil in Cuyama Valley, a small quantity was produced annually from the Arroyo Grande field 12 miles south of San Luis Obispo. Cuyama Valley is a northwest trending basin 50 miles long and 5 to 6 miles wide filled with Cretaceous and Tertiary marine sediments. Two productive zones have been discovered in the Russell Ranch field and one in the South Cuyama field (Santa Barbara County) lying 5 miles to the southeast. Producing sands are lower Miocene in age, lying at depths from 2,600 to 4,400 feet. Three small fields in the Morales Canyon area of North Cuyama were discovered by August 1950 after the drilling of 45 wildcat wells in the Cuyama-Carrizo region during 1950. By June 1950 the number of wells completed in the Russell Ranch field in Cuyama Valley totaled 138, about a fourth of which were in San Luis Obispo County. In April 1950, Superior Oil Company made the first of the north Cuyama discoveries by a 450-barrel per day well in sec. 2, T. 11 N., R. 28 W., 3 miles northwest of the Russell Ranch field. In the same area a 100-barrel pumping well was completed by the Hancock Oil Company, shortly after the initial discovery. The third discovery in north Cuyama was made by Hancock Oil Company which completed a 226 barrel-per-day well in August.

Richfield Oil Corporation was the largest producer in the valley. Richfield has constructed three pipe lines through which the oil is transported from Cuyama Valley to their pipeline system in the San Joaquin Valley, about 30 miles. These lines have a capacity of about 100,000 barrels per day. This company has also completed a natural gasoline absorption plant at the Russell Ranch field with a capacity of 15,000,000 cubic feet of casing-head gas per day. Facilities were provided for injecting residue gas back into the producing formations to maintain reservoir pressure. This injection practice is expected to aid oil production and increase the ultimate recovery. Production of Cuyama Valley under restricted flow was about 37,000 barrels per day in June 1950.

Nonmetallic Industrial Materials. The San Luis Brick Company, on South Broad Street, near the edge of San Luis Obispo, made common bricks from clay-shale and clayey sandstone obtained near the plant. This plant, operated only during clement weather in the summer months, ran for 4 months in 1949. When it was operated a hired carryall scraped the raw materials from the surface a few hundred feet north of the plant and stock piled them in an old clay pit at the plant. A bulldozer pushed the clay into a hopper from which it was loaded into a transfer car that was drawn by cable up a ramp to receiving bins at the top of the brick plant. After pressing and cutting, the bricks were hand-stacked on boards, and transferred by fork-lift trucks to the open-air drying yards. They were burned in natural gas-fired field kilns in batches of about 700,000. A crew of 20 to 23 men were employed. Some concrete bricks were made in an adjacent plant using pumice or sand as aggregate.

The sand and gravel plant of Walter B. Roselip, 2 miles east of Atascadero processed gravel obtained from a poorly-bedded deposit of stream gravel. An asphalt and ready-mix concrete plant were included in this operation. A Northwest dipper-type shovel dug the gravel and loaded dump trucks which hauled it to the rock plant. Most of the gravel was minus 6 inches. The crushing, screening, and washing plant, which had a connected electrical horsepower of 240 produced nine rock and gravel sizes. The whole operation employed 18 men.

J.W.V.

San Mateo County

San Francisco Bay supplied raw materials for two operators in San Mateo County: clay and shells for cement manufacture at Redwood City, and sea water for production of high-purity magnesium compounds at South San Francisco. Production of crushed stone in large volume for the construction industry of San Mateo and San Francisco Counties continued at several points. Exploration for oil was in progress in southern San Mateo County.

Mineral Fuels. Many thousands of acres of potential oil land are under lease by major oil companies in the La Honda area. Extensive geologic and geophysical work during 1949 preceded the first wildcat well in the area, begun by the Jergins Company in early 1950. Other companies holding leases include Richfield, Conoco, and Texaco. Leased areas embrace much of the mass of Tertiary marine sediments of southern San Mateo County.

Nonmetallic Industrial Materials. The Pacific Portland Cement Company's dredging operation is located south of the San Mateo Bridge and east of the ship channel, and is about 6 miles from the plant. The shell deposits, covered by less than 8 feet of water, have a maximum thickness of about 20 feet, the thinnest deposit usually worked is five feet. Suction dredges operating through 16-inch pipes pump to barges of 400-ton capacity. The barges are towed by tugs to the plant where an overhead clamshell crane transfers the mud and shells into a receiving hopper, or an outdoor storage pile. The mud-shell ratio may be adjusted by washing part of the material with rake classifiers before passing it to the raw grinding department. In the raw grinding department, five ball mills, operating in open circuit, grind most of the material to 100 mesh. After grinding, the slurry was pumped to mixing and storage tanks where the composition is adjusted before burning. Burning is done in four oil-fired rotary kilns 10 feet in diameter and 240 feet long. From the kilns the clinker drops to rotary counter-current air coolers, and thence to the finish-grinding department where four 2-compartment ball mills operate in closed circuit with air separators.

The Marine Magnesium Products Corporation of South San Francisco recovers magnesium salts from bay water with a process involving the precipitation of the magnesium as magnesium hydroxide by the addition of calcined dolomite and calcined limestone. The concentration of magnesium salts in the bay water is appreciably decreased by the influx of fresh water each spring. Since Shasta dam has regulated the run-off of the Sacramento River, the seasonal variation in composition of the water used in the plant has decreased. Under average conditions 42.5 pounds of magnesium carbonate was contained in each 1,000 gallons of sea water used. Bay water is pumped into the plant, where the first step in the process removes solid particles. Live organic matter is killed with chlorine gas; this and other solid material is settled in flocs of magnesium hydroxide and separated from the water in a Dorr-type thickener. After filtering through sand, the water is passed to the main precipitation tank, where a water solution of calcined dolomite is added and magnesium hydroxide precipitated. After being reclaimed from the precipitation tank, the magnesium hydroxide is purified by washing with fresh water. The principal products of this plant are magnesium carbonates, magnesium oxides, and magnesium hydroxide, which have numerous industrial and pharmaceutical applications.

Quarries were operated at Woodside, Brisbane, Redwood City, Belmont, Pescadero, and two each at Rockaway Beach and South San Francisco. Most of the rock quarried was chert, sandstone, and limestone from the Franciscan formation. A typical operation is the Golden West quarry on the southwest side of Visitacion Valley, above the Cow Palace in South San Francisco. The quarry is in northeast-dipping, blue-gray Franciscan sandstone, in which quarrying proceeds against a face 150 to 200 feet high. After blasting toe holes, broken rock is loaded by power shovel to trucks hauling to the rock plant at the mouth of the quarry. Five rock sizes are produced in the plant by crushing and screening, the average price for all sizes of rock being $1.05 per ton.

J.W.V.

Santa Barbara County

Petroleum was again the most important mineral commodity. The discovery of the South Cuyama oil field in the northern part of the county was an important event in the California petroleum industry, and was the second major oil discovery in the Cuyama Valley area in less than a year. Large quantities of diatomite were mined from an extensive deposit south of Lompoc and oil-bearing diatomaceous shale was mined near Casmalia. This shale was processed for use both as a block aggregate, and as a puzzolan in concrete. The Santa Ynez and Sisquoc River beds were the source of sand and gravel. Red-burning clay and mineral water were also produced.

Mineral Fuels. The South Cuyama field was discovered in April 1949 by a Richfield Oil Company well drilled 5 miles southeast of the Russell Ranch field. During the remainder of the year the proved area was rapidly expanded to the southeast. The wells had an initial flow of from 600 to 5,000 barrels per day of 33 gravity oil with negligible water cuts. Production was from the Dibblee sand (late Miocene).

In the Santa Maria area nearly all drilling was suspended because of drastic cuts in the price of crude oil. Three wells were drilled on Santa Rosa Island but no oil showings were encountered and the wells have been abandoned.

Nonmetallic Industrial Materials. The McNall Building Materials Company of Santa Barbara mined more than 3,000 yards of red-burning clay from an open cut on the San Marcos Pass road for use in the production of common brick, drain tile and floor tile. The clay was mixed and tempered in a horizontal mixer, then extruded and wire-cut to shape. All products were air dried and burned in a field type kiln. The kiln had a capacity of about 200,000 bricks and was fired by gas.

In the latter part of 1949 the Airox Company commenced producing a puzzolan from the diatomaceous shale deposit near Casmalia. This material was used to replace portland cement in concrete. The puzzolan differed from the regular Airox material produced for aggregate purposes in that it was prepared by a slightly different method and was ground very fine. The diatomaceous shale in the deposit contains some oil and some hydrocarbons in other forms. The hydrocarbon content is sufficient to support combustion under proper conditions. The shale was mined by rippers and bulldozers in an open cut, pushed over a grizzly-chute to the crushing-screening unit, and conveyed to storage bins. Then the shale was trucked to the horizontal, open-air burning beds. For production of the puzzolan, shale which was screened to minus $\frac{1}{2}$ inch plus $\frac{3}{16}$ inch, was mixed with 30 percent hydrocarbon-free shale and burned in the open beds. This resulted in a ''soft burn'', the maximum temperature never exceeding 1450° to 1500° F. When the burn was completed, the material was hauled to the Permanente Cement Company plant for fine grinding. Specifications called for grinding to a specific surface of 10,000 to 12,000 square centimeters per gram as determined by air permeability tests. The regular Airox aggregate was produced from shale which was screened to minus $1\frac{1}{4}$ inch plus $\frac{3}{16}$ inch in size. No hydrocarbon-free shale was admixed and the temperature of the burning beds reached a maximum of from 1850° to 1900° F. At the end of the burning period, about 10 days, the calcined shale was pushed into a pit and conveyed to the final unit for crushing and screening into minus $\frac{1}{8}$-inch sand, and minus $\frac{5}{16}$-inch plus $\frac{1}{8}$-inch aggregate for block mix. The ratio of Airox aggregate produced to the puzzolan material was about $2\frac{1}{2}$ to 1. The total burning capacity was reported as 600 yards per day.

Powdered diatomite products, pressed and natural diatomite brick, were produced by Johns-Manville Products Corporation, Celite Division, from the very extensive deposit of pure diatomaceous earth just south of Lompoc. All mining was done by power shovels in quarries. Only a small percentage of the crude diatomite was used for making brick, and this was trucked direct to the press house. The pressed bricks were dried and calcined. The crude material for the powder products was trucked to several vertical shafts, locally called ''glory holes'', which feed the cars operating in the underground haulage system, leading to the mill. The length of these underground tunnels, which serve several open pits in a 4,000-acre area, totals nearly 10,000 feet. The trains were hauled by electric trolley locomotives. The crude diatomite, containing from 40 to 50 percent moisture, was processed by crushing, drying and milling; some was calcined. For special purposes classification of the diatomite was made to obtain the desired proportions of the various diatoms. Natural bricks were cut directly out of a separate quarry near the brick plant by a special and unique cutting machine. These natural bricks were dried and sized. A total of nearly 500 persons were employed in these operations. During 1949 the company camps near the plant were abandoned and replaced by a housing project in Lompoc.

The Dicalite Division of the Great Lakes Carbon Company started test work on a diatomite deposit southeast of Lompoc in April 1949. A relatively small tonnage was mined by 18-yard carry-all type scrapers and hauled to the company's plant at Walteria for testing purposes.

The Grant and Grant Engineering Company performed some tests on the use of specially processed diatomite in concrete. They leased the National Silica Company property west of Lompoc and mined a small tonnage of diatomite.

The Southern Pacific Milling Company at Sisquoc produced between 500 and 600 tons per day of standard commercial sizes of crushed rock, sand and gravel. The Buell Flat Rock Company (Peterson Sand and Gravel) produced two sizes of crushed rock in the plant at Solvang on the Santa Ynez River. The capacity of the plant was 400 tons of washed material per day.

The Veronica Sales Company marketed mineral water from Veronica Springs on Los Positos Road on the west edge of Santa Barbara.

R.M.S.

Santa Clara County

The Permanente cement plant, largest in the world, consumed the output of a nearby limestone quarry. Substantial quantities of sand and gravel were produced at Campbell, Gilroy, Los Gatos, and San Jose. Crushed rock was produced at Los Altos and Palo Alto. Oyster shells were recovered from San Francisco Bay at Alviso.

Nonmetallic Industrial Materials. Limestone was quarried at the rate of 1½ million tons per year from the deposit of the Permanente Cement Company. The operation, located on the north side of Permanente Creek about a mile northwest of the cement plant, utilized a body of intensely folded, faulted, and fractured Calera limestone lying in the San Andreas fault zone. The limestone was quarried by benching, using a 5-yard Bucyrus-Erie shovel. The quarry production of about 5600 tons per day was crushed in two stages and conveyed to the cement rock storage piles adjacent to the cement plant. After further reduction to minus ⅜-inch in cone crushers, and in ball mills to 95 percent minus 200 mesh, the material was mixed with ground clay in the ratio of about 4 to 1 to make cement by the wet process. An andesitic clay was obtained from a mountain spur midway between the limestone quarry and the cement plant at the rate of 750 tons per day. The clay, mined by bulldozers and diesel-operated Le Tourneau carryalls, was pulverized in a hammer mill, a ball mill, and tube mills and then discharged to blending tanks and slurry storage.

The cement plant was composed of three units, namely: 1) the mill section where the cement raw materials were pulverized and mixed for ''burning''; 2) the kiln section where the pulverized raw material was ''burned'' or calcined to clinkers (lumps); and 3) the finish grinding section where the clinkers were pulverized into finished cement. All five types of A.S.T.M.-specification cement were made at this plant. The quarry operated 7½ hours per day on a 5-day week. The plant operated 24 hours per day on a 7-day week. Fifteen men were employed in the quarry and 425 men in the plant. The rated output was 5½ million barrels of cement a year.

The Western Gravel Company leased the Pacific Coast Aggregates property along Los Gatos Creek for a distance of about 2 miles west of Campbell. Gravel was mined from the creek bed at a depth of about 20 feet below the surface of the surrounding land. The gravel was mined by a carryall, which loaded to dump trucks by means of a ramp and an overhead grizzly, and was then hauled to the washing and screening plant at Campbell.

The Western Tile and Supply Company operated a sand and gravel plant on Uvas Creek about 6 miles west of Gilroy on the Hecker Pass road. This company controlled a stretch of 3 to 4 miles along the creek bed, which is about a quarter of a mile wide at the plant. Gravel is about 30 feet deep, and is replenished annually by winter rains. Few boulders over 6 inches in size were encountered. A clear, sandy gravel, with very little clay was produced.

Metals. A small quantity of quicksilver was produced from the Guadalupe and New Almaden mines. M. L. Burrell and associates had a lease at the Guadalupe mine where they drove an adit 45 feet, sunk a winze 35 feet, and drifted at that level. The ore was retorted. Harry Austin and his partner had a lease on Mine Hill at the New Almaden mine where they were mining cinnabar by hand methods. The ore was trucked about 2 miles to a D-retort for processing. Kirk and Stokesbury also had a lease on an adjoining part of the New Almaden property. They were using a bulldozer to uncover the ore which was trucked to the old mill-site on Mine Hill. Here the ore was passed through a 2-inch screen, and was loaded into a 6- by 16-foot vertical furnace. F.F.D.

Santa Cruz County

The value of portland cement produced at Davenport exceeded the aggregate value of all other mineral commodities. Three operators produced plaster sand and concrete aggregate from the Santa Margarita formation. Limestone for poultry grit was quarried at Santa Cruz, and granite was quarried for crushed rock.

Nonmetallic Industrial Materials. Cement was produced by the Santa Cruz Portland Cement Company at Davenport, a town on the coast 13 miles northwest of Santa Cruz. The principal raw materials required for this operation, limestone and clay, were obtained from quarries on San Vicente Creek 1½ miles northeast of the plant. Here, limestone and clay were blasted from the sides of steep-walled quarries and allowed to fall into glory holes from which they were drawn into underground bulldozing chambers, thence to haulage adits, and loaded into cars for transport to the mill. This cement plant, rated at 10,000 barrels per day capacity, is the only dry process plant in northern California. A distinctive feature of the plant was the use of Lepol-system kilns which achieved outstanding records for fuel economy. In this kiln system the material from the raw grinding department was rolled into small balls in a rotary nodulizer by the addition of water. From the nodulizer the balls dropped to a horizontal traveling grate where a 6-inch bed of balls was maintained. The balls were dried and partly calcined by kiln gases drawn downward through the grate. The grate discharged into a standard design short kiln for final burning. More than 70 percent of the cement produced here was shipped in bulk by truck and rail. Facilities were available for out-loading ocean-going vessels with bulk cement.

Henry J. Kaiser Company and Pacific Coast Aggregates, Inc., mined sand and gravel from the Miocene Santa Margarita formation on Zayante Creek near Olympia for use in plaster and concrete. The Santa Cruz Aggregates Company has been producing for 5 years from a pit on Mission Springs road and recently opened another pit on Glenwood road, 2 miles north of Camp Evers junction. A branch line of the Southern Pacific Railroad serves the plants near Olympia; all of the output from Santa Cruz Aggregates Company's pits was moved by trucks. Most of the sand produced in the county was marketed in the San Francisco Bay area. The sand was obtained from a stratum of nearly flat-lying, poorly consolidated, white to gray sandstone, about 200 feet thick, containing somewhat coarser material at the base. Small lenses of gravel occur in the upper part of the beds. Holes for blasting, placed at the crest or toe of the working face, were drilled about 15 feet deep with 6-inch post-hole augers. After blasting, the sand was moved with drag scrapers and conveyor belts to the washing and sizing plants. Certain areas of the sand deposits of the Pacific Coast Aggregates, Inc., were mined with a 14-cubic yard carryall which dumped the sand into the main pit within reach of the scrapers. The two plants near Olympia were rated at 125 tons of sand per hour; the Santa Cruz Aggregates Company plant was rated at 50 tons per hour. Water from the washing plants must be clarified in settling ponds before re-using or releasing it into the streams. Sand sold for about $1.00 per ton at the plants.

Limestone for poultry feed was produced in an interesting operation at the plant and quarry of the Pacific Limestone Products Company on the northern outskirts of Santa Cruz. The limestone, after being broken from the quarry face, was hand-sorted, and placed in skips of 1½-ton capacity. When filled, the skips were picked up by specially-adapted trucks for transfer to the plant. In the plant the limestone was crushed, sized, and sacked. Eight grit sizes and special mineral mixes were produced. This operation employed 25 men.

Two rock plants produced crushed granite: the Felton quarry southwest of Felton; and the Hanson-Silvey-Sinnott quarry, near Camp Evers junction east of Highway 17. J.W.V.

Shasta County

Large quantities of pyrite were produced near Redding and sold to chemical companies in the San Francisco area for use in manufacturing sulfuric acid. Zinc and copper concentrates were made from a complex ore mined at Ingot and were shipped to out-of-state smelters. Placer gold was recovered by bucket-line and dragline dredges, and a small quantity of high grade gold ore was shipped from a lode mine. Development work was done on chrysotile asbestos claims in the Highland Lake area and a small shipment of amphibole asbestos was made from Mears Creek. Sand and gravel for road building was produced by draglines in the vicinity of Redding.

Nonmetallic Industrial Materials. The Blas Asbestos Corporation widened and improved the road to Highland Lake for a distance of 8 miles west of Highway 99 to provide better access to their mining claims. Eight claims were located in Shasta County where crysotile asbestos was found in outcrops of serpentine and peridotite. Fiber ½ to ⅝ inch long was exposed in bulldozer cuts. An experimental milling plant, built near the highway at Eagle Roost Point, included a ''centrifugal force'' mill. This consisted of eight metal blades mounted on a 4½-inch shaft which rotated at 1800 revolutions per minute within a circular metal housing. The pulverized material was subjected to a blast of air from a centrifugal blower. The lighter material was carried into a metal container from which it was loaded into paper sacks. All of the product was very fine and no attempt was made to produce fiber. A few tons of the material were processed but none was marketed in 1949.

A few tons of amphibole asbestos were shipped from the old Stock Asbestos Mining Company property on Mears Creek which was operated by the Loma Blanca Mines, Incorporated. The asbestos occurs as lenses in serpentine and was mined by bulldozer cuts and a short adit. It was used principally for filters.

The J. H. Hein Company gravel plant adjacent to Highway 44 and on the east bank of the Sacramento River was active in 1949. The gravel was dug with draglines to a depth of 8 feet below water level. Material over 3 inches in size was crushed in a jaw crusher and rolls and delivered by a belt conveyor to shaking screens. The plant had a capacity of 500 tons in 8 hours. The company also operated a hot mix plant. An oil-fired rotary dryer heated the gravel to 300°-500° F. The hot gravel was screened into $\frac{3}{4}$-, $\frac{3}{8}$-, and $\frac{3}{16}$-inch sizes and the specified amount of each size was weighed into a batch hopper. The gravel and oil were mixed in a pug mill and the hot mixture was loaded into trucks for delivery. The plant had a capacity of 500 tons in 8 hours.

The Oaks Sand, Gravel and Cement Products Company produced sand and gravel for concrete aggregate and for road-building at its plant near the mouth of Clear Creek south of Redding. The gravel was dug 8 to 10 feet deep using a Lorain dragline fitted with a $\frac{3}{4}$-yard bucket. Sand from the screening plant was run through steel launders, fitted with expanded metal over burlap, and a small amount of fine gold was recovered. The capacity of the plant was increased to 300 yards per day. The concrete block plant had a capacity of 2,000 cement or pumice blocks in 8 hours. Twenty-five men were employed.

Metals. The Afterthought mine at Ingot was operated by the Coronado Copper and Zinc Company. The complex zinc-copper ore body is a replacement type deposit and includes additional values in lead, silver, and gold. The ore was mined from stopes above the adit level and concentrated in a selective flotation plant. The zinc concentrate was shipped to Great Falls, Montana, and the copper concentrate to Tacoma, Washington. In July 1949 the mine was closed down for an indefinite period.

The Mountain Copper Company, Ltd., produced pyrite from a massive sulphide deposit in their Hornet mine at Iron Mountain northwest of Redding. The pyrite was mined in room and pillar stopes. It was drilled by stoper drills, blasted down into scram drifts, and pulled by scraper to transfer raises over the haulage level. On the haulage level the pyrite was loaded into cars of 10-ton capacity and trains of five or six cars were pulled by a trolley locomotive to the ore bins. Here, the ore was crushed and screened to $\frac{3}{8}$-inch size and transported to the railroad at Matheson by an aerial tramway. Shipments were made to chemical plants in the San Francisco Bay area where the pyrite was roasted for the recovery of sulphur dioxide gas. This gas was used in the manufacture of sulphuric acid. Some copper and silver were recovered by leaching the roasted sinter. The iron residue was stock piled. A shipment of 5,000 tons of pyrite was also made to Formosa in 1949.

Roy S. Olson operated his dredge on a property northeast of Buckeye when water was available. The gravel was dug about 5 feet deep to a soft porphyry bedrock using a dragline equipped with a three-quarter-yard bucket. The Bodinson washing plant was built on a wooden hull 30 feet wide by 32 feet long. The trommel was 4 feet in diameter, 22 feet long, and sand was distributed to steel sluice boxes on both sides of it. Gold was caught with Hungarian riffles and expanded metal over burlap. About 700 cubic yards of gravel was dug and washed in a 10-hour day.

The Sunshine Gold Mining Company held a group of claims near Schilling. A drift east from the old Spanish adit developed a quartz vein 6 to 8 feet wide with walls of quartz diorite. A raise was run from the drift 70 feet to the surface. Gold was associated with pyrite and some chalcopyrite. The ore was stock piled while waiting for electric power to be connected to the treatment plant which was equipped with a ball mill, classifier, jig, amalgamator, and flotation cells. No gold production was reported.

The Thurman Gold Dredging Company operated a bucket-line dredge on Clear Creek south of Redding. The gravel was dredged 21 feet below water level to a soft clay bedrock. No boulders were present. The dredge was built on 33 steel pontoons making a barge 50 by 112 feet. The digging ladder carried 69 buckets of 9-cubic foot capacity and the trommel was 7 feet in diameter and 33 feet long. The gold was fine and was recovered in sluice boxes fitted with Hungarian riffles. In a year's operation 7 or 8 ounces of platinum metals were recovered. The dredge handled about 10,000 cubic yards in 24 hours. Twenty men were employed.

Lessees worked the Yankee John mine south of Redding in 1949. Gold occurred in brecciated quartz and was associated with calcite, pyrite, and arsenopyrite. The ore was mined from a drift and stope south of the shaft on the 100-foot level. A few truckloads of high grade ore were shipped to the smelter.

J.C.O'B.

Sierra County

A substantial quantity of gold was produced from the mines of Sierra County. The principal output was from lode mines, where high grade gold ore is found in quartz veins associated with pre-Cretaceous igneous and metamorphic rocks. Some gold production was also made by placer mines. Silver was produced as a by-product of gold mining operations.

Metals. The Best Mines Company shut down their Gold Point mine in January, 1949, and moved the equipment to the Gold Bluff mine. Here, two veins have been worked, each having a porphyry hanging wall and slate footwall. The Fault vein, 3 to 5 feet wide strikes N. 20° W. and dips 70° E.; the Crescent vein averages 5 feet in width, strikes N. 60° E. and dips 45° N. Former operators stoped out the veins from an old adit to the surface, 600 feet above, and to a depth of 800 feet below the adit level. Best Mining Company's work consisted of rehabilitation of the old adit for a distance of 1600 feet, dewatering the shaft to the 800-foot level, and retimbering the north drift for 400 feet. Some pillars which had been left for ground support were mined. The ore, in which gold is associated with pyrite, was milled at the Oxford mill, leased by the Best Mines Company.

The Brush Creek mine in the Goodyear Bar district was operated by Alfred L. Merritt in 1949. The mine is developed by a 600-foot adit driven S. 80° W. to a quartz vein which strikes N. 20° W. and dips 30° W. The vein is 5 to 6 feet wide with a serpentine footwall and a black slate hanging wall. It has been stoped 200 feet to the upper level and an additional 50 to 60 feet to the surface. The ore was hauled to the milling plant about 2 miles north of the mine and along the Goodyear Bar road. The gold was free and was recovered by crushing and amalgamation.

The road to the Colony placer mine in the Mountain House district was repaired. Machinery and equipment, including diesel-powered generators, trommels, shaking screens and sluice boxes, were moved to the property. There was no production in 1949.

The Dickey Exploration Company reopened the Gold Star placer mine in the Alleghany district. The mine is developed by a 2,000-foot adit driven N. 20° W. to the channel. The gravel, 8 feet thick, was difficult to work because of heavy ground conditions. The operation was closed down in March 1950, and the crew of six men were moved to the Oriental mine. No gold production was reported for 1949.

An attempt to reopen the Hub mine in the Alleghany district was abandoned in April when the old workings were found in bad condition.

John O'Donnell holds a lease on the Kate Hardy mine southwest of Forest, where development work has been in progress for several years. A rich vein containing gold associated with pyrite and arsenopyrite was opened in 1949. The ore was discovered 50 feet above the adit level in a raise, located 500 feet from the portal.

The Ace High Mining Corporation reopened the main adit of the Keystone mine in the Sierra City district for a distance of 4,000 feet. Track was laid and new timbers were placed. A 2-stamp mill, two copper amalgamation plates, and a concentration table were installed. A crew of seven men was employed from May to November. No gold production was reported.

The channel of the Kirkpatrick mine in the Forest district was prospected from April to December. At a point 2,400 feet from the portal, a raise was driven 70 feet above the adit, and the channel was drifted on for 150 feet north and south. The channel ran north and it was about 200 feet wide. The gravel, 18 to 30 inches thick, was covered with soft brown silt and underlain by a fine-grained, gray and black rock, which contained pyrite and thin seams of quartz. Gravel was dumped from the mine cars into a wooden chute and washed with mine water through 70 feet of sluice boxes fitted with Hungarian riffles. Four men were employed.

The Old Macchaus mine in the Alleghany district was leased by Fred Hamberg and renamed the Liberty mine. A compressor was installed and the adit was reopened for a length of 350 feet. Three men were employed. No production of gold was reported.

The Poorman and Hastings placer mine, now known as the Middle Yuba mine, is on the Middle Fork of the Yuba River about 1½ miles west of Foote Crossing. It was operated by the Crescent Pacific Mining Company in 1949. A portion of the old river channel has been blocked by a landslide and the original river gravel was covered by silt and another bed of gravel to a depth of 30 feet. The overburden was stripped from a bar 35 feet wide and 225 feet long with a dragline equipped with a 2-yard bucket. The river was diverted to the side of the bar and the gold-bearing gravel was dug with a ¾-yard dragline. The gold-bearing gravel was 5 feet deep and overlay a hard, fine-grained, black-colored bedrock. The abundant coarse gold nuggets were easily removed from the bedrock by hand. The gravel washing plant consisted of a trommel screen with four cross sluices and a downstream sluice on each side. It was mounted on angle irons and equipped with log skids. Fifteen men were employed in October 1949.

The Monarch mine 6 miles northwest of Sierra City was reopened in 1949. The mine has been worked through a 2-compartment vertical shaft 334 feet deep sunk in the hanging wall of the vein. The 334-foot level was cleaned out and retimbered for 250 feet north of the shaft. A new shaft house, a compressor house, and foreman's home were built with lumber sawed at the mine sawmill. Milling machinery including a jaw crusher, ball mill, and classifier were on the property awaiting installation. A crew of 14 to 16 men was employed from June to September. No gold production was reported.

The Mugwump placer mine was reopened in 1949 by Mrs. Virginia Thompson who has a lease and option on the property. Four men worked from July to January in repairing 800 feet of the adit.

The Sixteen to One mine in the Alleghany district was active in 1949. Highest gold values are associated with arsenopyrite and the high-grade portion of the vein ranges from 5 to 15 feet wide. Much fine pyrite is present but the total amount of sulphides is less than one-half percent. The ore was mined on the 2,400-foot level in the south part of the mine, hoisted to the 1,300-foot level through a 2-compartment winze, and then hauled 450 feet north to the skip pocket at the Sixteen to One shaft. The mine operated on day shift and the mill on the night and morning shifts. Forty men were employed at this property.

The Yellow Jacket Consolidated Gold Mines, Ltd., employed 5 men in developing the Osceola claim in the Alleghany district. A crosscut was driven 1200 feet west from the main adit level at a point 2,000 feet northwest of the portal. Wet and heavy ground was encountered and the heading was bulkheaded. A 60° inclined shaft was sunk from a point 250 feet east of the vein to a depth of 500 feet. From the shaft, the 350-foot level was driven 300 feet south to the endline of the Sixteen to One claim. On the 500-foot level, a drift was driven 150 feet north on the vein. The vein is as much as 20 feet in width, strikes N. 20° W., and dips 40° northeast. Both walls are amphibolite schist. No gold production was reported during the year.

The Yellow Jacket placer mine in the Alleghany district produced a small amount of gold in 1949. Gravel, mined from a prospect crosscut, located 900 feet from the portal of the adit, was washed in sluice boxes.

The Pride hydraulic mine is on Deer Creek about a mile south of Bassett. Water was taken from Deer Creek through 7,600 feet of 5 by 6-foot ditch and supplemented with water taken from Williams Creek through 1,100 feet of ditch. It was delivered to the monitors under a 550-foot head through 900 feet of double-riveted steel pipe laid on a 45° slope. A crew of seven men worked 115 days repairing roads, bridges, and ditches. The Thousand and One mine 2 miles south of the Pride mine was reopened under the same management. The old adit was retimbered for a distance of 120 feet.

J.C.O'B.

Siskiyou County

Light-weight mineral materials were mined in substantial quantities in the Mount Shasta and Glass Mountain areas. These included volcanic cinders, andesitic sand, and pumice. They were used chiefly in the preparation of light-weight aggregate for the construction industry. The principal gold output was from dredge operations, although some production was made by lode and hydraulic mines. Development work was in progress at several gold and copper properties. Sand and gravel were produced from dredge tailings piles near Yreka.

Nonmetallic Industrial Materials. Light-weight building blocks were manufactured from volcanic cinders mined on the west slope of Cinder Cone Mountain, 8 miles northeast of Weed. The cinders that lie in unconsolidated beds were shoveled by hand into nine-yard dump trucks, and hauled a distance of 35 miles to the plant of the Shastalite Block Company at Yreka. The cinders, largely minus one-inch in size, were passed through crushing rolls, which produced a minus one-quarter-inch product. Blocks were manufactured in a hydraulic press-type block machine, having a capacity of two thousand 8 by 8 by 16-inch blocks in 8 hours.

The Boorman Pumice Products Company mined and shipped pumice from a deposit in the Glass Mountain district, 8 miles west of Tionesta. The pumice occurs in a bed 4 feet thick overlying a lava flow; few pumice fragments exceed 1 inch in size. A bulldozer was used to move the pumice to a ramp, beneath which trucks were loaded. The crushing plant was located on the railroad at Tionesta, where the material was crushed to minus one-quarter-inch size by rolls and loaded into railroad cars with a bucket-elevator. About 75 percent of the pumice was shipped by rail.

The Mount Shasta Sand and Gravel Company mined its deposit of andesitic sand and gravel, using a dragline equipped with a three-quarters-yard bucket. The gravel was crushed, washed, and screened into sizes suitable for concrete aggregate. A concrete batching plant was installed during the year.

A. (Nick) Young of Yreka used a power shovel to load sand and gravel from the old dredge tailings piles on Yreka Creek, 4 miles southwest of Yreka. The tailings consisted mainly of fine-grained gray and black trap rock and quartz pebbles, and included cobbles up to 8 inches in size. The cobbles were crushed in a jaw crusher and separated into standard spray-washed products by a trommel and a double-deck vibrating screen.

Metals. The Chalco copper mine, formerly the Houston mine, comprises 20 acres of patented land southwest of Gazelle. A small quantity of copper ore was mined from surface cuts in 1949, but the grade was too low to ship profitably without milling.

E. A. McBroom operated the Farnsworth hydraulic mine on the South Fork of the Salmon River, southeast of Cecilville. The bank in the pit was about 35 feet high, and included 6 to 10 feet of gravel above a soft serpentine bedrock. The gravel contained many boulders. Water was obtained from the South Fork through 5½ miles of ditch, and delivered to the giants under a 200-foot head. The gold was recovered in a 36-by-36-inch sluice box, 90-feet long, fitted with steel rail riffles.

The French Gulch Dredging Company operated a bucket-line dredge on Indian Creek, north of Fort Jones during the year. The digging ladder carried 74 buckets of 4½-cubic foot capacity. Gravel was dredged 27 feet below the water level. Gold was recovered in metal sluice boxes fitted with rubber Hungarian riffles. The dredge was operated on three shifts, with 16 to 18 men being employed.

E. W. Little and Sons operated a dragline dredge on McAdam Creek about 6 miles north of Fort Jones. The upper 5 to 7 feet of the surface was stripped with a bulldozer, and the underlying 12 feet of gravel was dredged to a hard red-colored volcanic bedrock. Occasional boulders were encountered and proved troublesome. The washing plant, built on six steel pontoons, included a trommel 5 feet in diameter, and covered with 20 feet of $\frac{1}{2}$- to $\frac{3}{8}$-inch screen. Gold was caught in cross sluice boxes fitted with steel Hungarian riffles, and in down-stream boxes fitted with expanded metal over burlap. The dredge worked 8 hours per day.

The Northwestern Mining Company operated the Vest hydraulic mine on the north bank of the North Fork of the Salmon river, 7 miles east of Forks of Salmon. The deposit consists of about 12 feet of gravel, with 50 feet of overburden, including many granite boulders. Water was brought from Jones Creek through half a mile of ditch and 1500 feet of steel pipe, and was delivered to the monitor under 80 pounds pressure. The monitor was fitted with a three-inch nozzle. A six-inch centrifugal pump delivered additional water from the river as required. Gold was caught in 300 feet of 24- by 24-inch sluice boxes fitted with block riffles. A derrick with a double drum hoist was used to handle boulders.

The Reeves Ranch dredge continued in operation on the west bank of the Klamath River, 2 miles northeast of Happy Camp. The dredge was equipped with a bucket line that carried 66 buckets of four-cubic feet capacity. Gravel was dredged to a soft schist bedrock at depths ranging from 21 to 30 feet. Much of the gold was caught on copper amalgamation plates in the distributing launders beneath the trommel. The sand was discharged to two Pan American rougher jigs, and to a series of sluice boxes fitted with Hungarian riffles or expanded metal over burlap. The dredge operated on three shifts per day, employed 12 men, and dug about 2600 yards of gravel per day.

The Yuba Consolidated Gold Fields operated a bucketline dredge on the Scott river, about 3 miles north of Callahan. The boat was built on a steel hull, 144 feet long, 64 feet wide, and 10 feet deep. A digging ladder, 112 feet long, carried 83 nine-cubic-foot buckets. The dredge dug to a maximum depth of 52 feet below the surface of the pond, and carried an 8-foot bank. A trommel, 8 feet in diameter, and 48 feet long, with 34 feet of screen, discharged oversize gravel to a 150-foot stacker. Side sluice boxes were double banked, with 3,500 square feet of table area. Gold was caught with steel-shod wooden riffles. The dredge, operated on three shifts per day, employed a total of 21 men, and removed about 400 cubic yards of gravel per hour.

The Siskon Mining Corporation prospected a gossan outcrop in the Dillon Creek district, about 5 miles north of Cedar Camp at a point 13 miles west of the Klamath River highway. About 29 claims are located on a schistose band of greenstone, which trends northwesterly for a distance of approximately 7,000 feet. Former operators had driven short adits in the greenstone beneath the gossan, but none had developed ore of commercial grade. A road 5 miles long was built to the property, and a camp established in 1949. The surface was prospected with bulldozer cuts and two diamond drills cored a total of 5,000 feet of hole. The core recovery was very poor because of the sheared and broken nature of the rocks. Part of the recovered core showed a considerable amount of fine pyrite, some pyrrhotite, and small quantities of zinc and copper sulphides. Occasional high gold assays were obtained from some surface exposures. The oxidized zone was found to extend irregularly to depths of as much as 500 feet.

Development work progressed in two adits at the Sugar Loaf group of claims southwest of Callahan. A quartz vein with diorite walls in the

Big Blue adit strikes N. 70° E., and dips 45° N. The vein 20 feet wide at a point 75 feet from the portal, consists of sheared quartz in which some of the thin cracks and seams are filled with chalcopyrite, malachite, azurite, or bornite. The quartz vein in the Granite adit is 10 to 21 inches wide, strikes N. 45° E., and dips vertically. The quartz vein, enclosed in a diorite and shale hanging wall and a diorite footwall, contains seams of pyrite and some sericite. The treatment plant included a 25-ton Huntington mill, copper plates, a Diester table, and two 8-foot diameter wood-stave cyanide leaching tanks. No gold production was reported in 1949.

J.C.O'B.

Solano County

Solano County was one of the leading producers of natural gas. Most of the production came from the Rio Vista field in the southeastern part of the county. This field extends southeastward into Sacramento and Contra Costa Counties. Smaller producing fields discovered in the period 1944-48 are: Millar and Maine Prairie, southeast of Dixon; Kirby Hill, southeast of Fairfield; Cache Slough, north of Rio Vista; the east shore of Suisun Bay; the north shore of Honker Bay; near Winters; and near Denverton. All of the production from these fields came from Eocene formations, with the exception of that from Denverton and one well in the Kirby Hill field, which was believed to come from the Cretaceous. Crushed rock, sand, and gravel were produced and used in the construction of Highway 40.

Mineral Fuels. The Rio Vista field has been described by Frame.[2] It is estimated that the field originally contained 3,536,793,000 thousand cubic feet of gas of which more than 1,000,000,000 thousand cubic feet has been produced to date. The heat content of the gas from this field was high (1040 B.t.u. cu. ft.) compared with other dry natural gas fields in the state. The Kirby Hill gas field, discovered in 1944, has become the fourth most productive gas field in northern California. This field also has been described by Frame.[3] It was estimated that the total gas in place in the Kirby Hill field was 49,235,000 thousand cubic feet of which 8,616,599 thousand cubic feet had been produced up to July 1, 1949. Thirteen wells were completed in the Rio Vista field during 1949, most of them in Solano and Sacramento Counties. No other wells were completed in known productive areas in Solano County. A pipeline connecting the Winters field with the distribution system of the Pacific Gas and Electric Company was completed during the year.

Nonmetallic Industrial Materials. Harms Brothers operated a quarry half a mile east of Vacaville in a hillock of poorly consolidated continental Pliocene conglomerate. Few boulders larger than 6 inches were encountered. A large mass of similar material extends northward for several miles. The conglomerate was mined with power shovels without blasting. Crushed rock suitable for use in asphalt and concrete was produced by screening out the sandy matrix and crushing the coarser material.

At the J. M. Nelson quarry, rock was blasted from a flow of olivine basalt which was capping a hill. Widely spaced joints in a face 25 feet high permitted the basalt to break into large fragments. The rock was loaded into trucks by power shovel for transfer to the primary crusher. The material was re-crushed and screened at the quarry, and transferred down the hillside to stock piles by a conveyor-belt system. J. M. Nelson operated an asphalt plant in connection with this quarry.

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[2] Frame, R. G., Rio Vista gas field: California Oil Fields, vol. 30, no. 1, pp. 5-14, 1944.

[3] Frame, R. G., Preliminary report on Kirby Hill gas field: California Oil Fields, vol. 35, no. 1, pp. 13-21, 1949.

Parish Brothers operated a quarry at the southern end of the hills northeast of Benicia. The rock was quarried from a bed of tuff, vesicular, basaltic breccia, occurring in the Sonoma volcanics. Bulldozers and carry-alls removed and transferred the rock to the crushing and screening plant. J.W.V.

Sonoma County

The Mt. Jackson quicksilver mine operated continuously throughout the year, and in May 1950, was the only major quicksilver producer in the United States. Sand, gravel and crushed rock accounted for a large part of the mineral output. Small quantities of flagstone, colored building stone, natural gas, and petroleum were also produced.

Nonmetallic Industrial Materials. One of the most successful sand and gravel operations was that of the Basalt Rock Company south of Healdsburg on the Russian River. The company controls the gravel deposit for a stretch of about 2½ miles along the river in the vicinity of the plant. Mining was done by means of a Bucyrus W-3 Monaghan dragline, using an 80-foot boom and a 4-yard bucket. The outfit was mounted on a walker and was electrically operated by power from a portable generating set. The dragline traveled on a bank about 12 feet above the normal water level, and dug to a depth of about 40 feet below the water surface. All digging was done in a pond to prevent roiling of the river. The excess gravel not used in the plant during the summer months was stock piled for winter use, because high stream waters and the possibility of caving banks prevent operation of the dragline during the rainy season. By the time wet weather has set in, the company has usually accumulated a raw storage of about 1½-million tons.

Crushed rock was produced at the Hein Bros. Basalt Rock Company quarry southeast of Petaluma. This quarry was opened about 25 year ago in a flow of basalt about 100 feet thick, capping a small hill.

The rhyolite-flow rocks in the Sonoma Valley, especially near Glen Ellen, were the source of flagstones and colored building stone. This material was produced on an intermittent basis, and the services of only one or two men were required at each quarry. The rhyolite, banded in many places, was split readily into blocks up to 3 inches in thickness, and was trimmed by hand.

Metals. The Mount Jackson-Great Eastern quicksilver mine near Guerneville was operated by the Sonoma Quicksilver Mines Company. The Mount Jackson, Great Eastern, and the Roaring Lion prospects have been consolidated under one management, and most of the work of mining was westward from the old 620-foot level. New levels were established at the 690-foot and 775-foot points. The 875-foot level has been reached by a winze in ore, and drifts were being driven northwestward toward the main shaft. Meanwhile, ore was hoisted through the winze to the 775-foot level, thence trammed to the main shaft through which it was hoisted to the entry drift. From here it was hand-trammed to the portal of the mine. The mine was dry and the temperature moderate all year round, averaging about 65° F. Good, natural ventilation prevailed and forced-air ventilation was required only when running a heading.

Exploration underground was done with diamond drills. The walls of all development openings (winzes, drifts, and crosscuts) were sampled by drilling, and assays made of mine rock. Grab samples were taken on each carload to control the grade of ore going to the furnace. The tailings were assayed and recovery amounted to over 99 percent. Low mining costs resulting from shrinkage-stope mining methods permitted the mine to operate even though the price of quicksilver fell to the low figure of $70 per flask.

Local timber at reasonable rates was obtained for entry supports, shafts, pockets, and chutes. The rock was drilled, blasted, and machine-loaded on the same shift. The faces were drilled to a 6-foot depth, using detachable bits. The mineralized body consisted of a large area, circular in dimension, extending downward from the surface. Cinnabar was the ore mineral, and no free mercury has been found in this mine. Ore from the mine was dumped over an 8-inch grizzly to Kue Ken jaw crushers for reduction to minus 1½-inch size. Two rotary-type furnaces were used, one rated at 80 tons, and the other at 40 tons per day. Ore was fed to the large furnace by a bumper feeder at the rate of 1 to 8 tons per hour, depending on the grade of the ore. High-grade ore was fed at a slower rate than low-grade. Sirocco dust collector, condensers, redwood tanks, and stacks constituted the balance of the recovery system. Most of the quicksilver was recovered in the first few condenser buckets. The last buckets in the bank were opened only once in 3 or 4 months. Temperature in the first condenser ran around 450° F., and fell to about 150° F. in the stack. Quicksilver recovery ranged from 5 to 10 pounds per ton of ore. The mine operated a 6-day week, and the furnace ran 24 hours a day on a 7-day week. In April 1950, 35 men were employed. F.F.D.

Stanislaus County

Pumicite was mined in the foothills west of Crows Landing and processed in a plant located at that town. Sand and gravel was produced at Oakdale, Modesto, Newman, Riverbank, Turlock, and along the Tuolumne River between Modesto and Waterford. A bucket-line gold dredge operated on the Tuolumne River between Waterford and La Grange. Small quantities of natural gas were produced at Vernalis, Modesto, and Waterford. Some raw clay was produced at Knights Ferry.

Nonmetallic Industrial Materials. The Base Materials Company moved its plant from Patterson to Crows Landing, acquired its own deposit of pumicite about 6 miles west of the latter town, and was mining the deposit with a half yard shovel. The material was crushed at the quarry to minus 6-inch size and trucked to the plant, located alongside the main line of the Southern Pacific Railroad in the center of town. The crusher-run material was dumped into a concrete storage bin at ground level, and was carried by a chain conveyor to a short bucket elevator, and thence to crushing rolls. Here, secondary crushing reduced the raw material to a minus one-half-inch product, which was elevated to a Madson counter-current drier about 4 by 20 feet in size. A maximum temperature of 1100° F. was reached in the drier. The material was discharged at a temperature of about 300° F., with the original moisture content, which runs about 30 percent, being reduced to zero. The drier product was delivered to the classifying room, bulk storage bins, and bagging system by a vertical bucket elevator about 60 feet long. The final product was sold either in bags or in bulk as desired by the particular consumer. The following products were made: chicken litter, minus one-half-inch, plus 25-mesh; oil absorbent, minus 8-mesh, plus 50-mesh; physical soil conditioner, minus 25-mesh, plus 100-mesh; fillers for fertilizer and other products, minus 100-mesh, plus 325-mesh; and insecticide carriers, minus 325-mesh. The company employed a total of five men in the quarry and plant, and the latter was run on one daylight shift of 9 hours. The plant had a capacity of 25,000 tons per year, although full production had not yet been attained.

The Cro-Diatomite Company of Modesto continued to mine a similar white, fine-grained pumicite from their deposit in the foothills southwest of Crows Landing. They have installed a drier at the quarry, and were processing the material for use as an additive to cement. This pumicite has certain puzzolanic properties, which are very desirable in cements used in dams and other water-resisting structures.

The Santa Fe Rock and Sand Company, Modesto, in 1947 began a sand and gravel operation on the Michael Ranch, McEwen Road, near Waterford along the north bank of the Tuolumne River. A dragline with a 2½-yard bucket and a 60-foot boom dug 25 feet into the river bed and loaded directly to a 15-ton Caterpillar carry-all or to a 10-ton Caterpillar jeep, which hauled to the screening plant situated on an upper terrace of the river about an eighth of a mile away. The plant was designed with two sections so that it could be operated either as a plant-mix unit, or as a washed rock unit. This operation employed seven men on one shift daily for 5 days per week. The capacity of the plant was rated at 1,000 tons per day.

Charles Warner operated a sand plant on the Tuolumne River between Modesto and Hughson, and also operated a slack-line cableway on the south bank of the Tuolumne River about 1 mile west of Hickman, where sand and gravel was produced. The slack-line cableway carried a 2-yard bucket, was supported by a 100-foot gin pole, and was operated by a double-drum hoist. This equipment dug 40 feet below the surface of the river water where a hard bedrock was encountered. It was necessary to move the position of the cableway about once in every 3 months. The excavating bucket dumped its loads to a hopper atop the screen plant, where the products were dropped through to the storage bunkers. Two men operated the plant, which had a rated capacity of 500 yards per day.

Metals. The La Grange Gold Dredging Company, principal metal producer during 1949, operated their dredge midway between Waterford and La Grange. This was a connected-bucket dredge of the Yuba type equipped with 62 buckets of 10-cubic-foot capacity, mounted on a digging ladder about 75 feet long. The 5-foot trommel was perforated with ¼- to ⅝-inch holes. Hungarian riffles were used on the gold saving tables. Nine transverse tables and five longitudinal tables were used on each side of the trommel. An 11-inch centrifugal pump line provided water for washing. The bucketline dug to bedrock located about 40 feet below the water level. The Tuolumne dredge located 1½ miles south of the town of La Grange operated during the first 2 months of the year.

F.F.D.

Sutter County

The most significant activity in the mineral industry was the continued output of natural gas from the Sutter Buttes field. Raw clay and crushed rock were produced near Nicolaus and Sutter Buttes, respectively.

Mineral Fuels. A gas field (owned by Buttes Oilfields, Inc.) located on the southern flank of the Sutter Buttes, has been developed in Upper Cretaceous sediments at depths ranging from 5365 to 6882 feet. Seven wells have been drilled in a proved area of 840 acres. This gas contains 99.68 percent methane, 0.24 percent ethane, and 0.10 percent carbon dioxide, and has a calorific value of 1,014 British thermal units. Light amber oil, apparently derived partly or wholly from pine cones or pine wood, occurs in small quantities with the gas; however, no production of oil has been reported in recent years. Total production of natural gas during 1949, obtained from an average of five of the seven wells, was 620,068 thousand cubic feet. This gas was delivered to commercial and domestic consumers in Marysville and vicinity. No wildcat activity took place during the year, and total reserves of the field, as of December 31, 1949, were 15,458,207 thousand cubic feet.[4]

Nonmetallic Industrial Materials. Gladding, McBean and Company obtained raw clay from an open pit approximately 1 mile east of Nicolaus. A 1½-yard power shovel was used to mine the clay which was hauled by truck to the Lincoln plant for utilization. The material obtained was a light reddish-brown clayey silt, and was blended with other clays in the production of sewer pipe and roofing tile. The pit, approximately 850 feet long, 400 feet wide, and 10 feet deep, has been operated more or less continuously for several years.

Crushed rock, for use in road construction in Sutter County, was produced from a pit on the southern flank of Sutter Buttes by Rice Brothers of Marysville. The pit, located in sec. 10, T. 15 N., R. 1 E., was in tuffaceous andesitic agglomerate. The rock was excavated with a bulldozer and processed with a portable crusher. Operations at this pit were discontinued late in the year and all equipment removed.

S.J.R.

Tehama County

The mining activity in Tehama County in 1949 was confined to the production of sand, gravel, and crushed rock from deposits on the west bank of the Sacramento River and tributary streams. The material was used for concrete aggregate and for road building.

Nonmetallic Industrial Materials. Allen and Reddy operated a portable Cedar Rapids crushing and screening plant on Paynes, Thomas, and Reeds Creeks intermittently during the year. The gravel was removed from the creek beds with a half-yard dragline bucket.

The Baker Trucking Company operated a gravel pit on the south bank of Thomas Creek about 2 miles east of Highway 99-W. The pit material included sand and pebbles of the Tehama formation and few cobbles over 4 inches in size were found. Dump trucks were loaded with a dragline and the material was hauled about an eighth of a mile to the crushing and screening plant. A cold oil-mix service was added to the plant in 1949. A crew of 12 to 15 men was employed and plant capacity was 200 cubic yards of screened sand and gravel per day.

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[4] Bush, R. D., Summary of Operations, California Oil Fields, vol. 35, no. 2, p. 42, 1949.

Draper and Adams operated a sand and gravel crushing and screening plant and a concrete batching plant on the east bank of the Sacramento River in Red Bluff. The river gravel was pulled into a hopper with a 1-yard scraper. About 35 percent of the material was minus ¼ inch and few boulders were over 12 inches in size. The plant can process 100 tons of sand and gravel per hour. The concrete batching plant has a capacity of 500 cubic yards in 8 hours.

Liston Ehron frequently loaded gravel from the east bank of the Sacramento River near Red Bluff. A dragline equipped with a ⅜-yard bucket was used to dig the gravel and load the 5-yard dump trucks.

Wm. G. Taber and son mined sand and gravel from bars on the east side of the Sacramento River north of Highway 99-E at Red Bluff. The gravel was dug with an International tractor equipped with a Bucyrus Erie ¼-yard bucket-loader.

J.C.O'B.

Trinity County

Placer mining for gold was the most important phase of the mineral industry in Trinity County. These placer operations involved the handling of large quantities of gravel by bucket-line dredging, drag-line dredging, and hydraulicking. Many of the operations were intermittent or seasonal in character. Hydraulic mining operations, for instance, were conducted only during the season of abundant water supply in the spring of the year.

Metals. Remodeling of the Junction City dredge at its new location on the Trinity River near Minersville was completed by the Fairview Placers in September. Six pontoons were added to the barge. The digging ladder was lengthened 8 feet and now carries 77 buckets of 10-cubic foot capacity. The old series of sluice boxes has been discarded in favor of Yuba placer jigs, consisting of 26 rougher jigs and two cleaner jigs which recover the gold. The gravel is 24 to 35 feet deep above a soft serpentine bedrock. Capacity of the dredge is 8,000 cubic yards in 24 hours.

A development crosscut 160 feet long was driven on the No. 3 level of the Kelly mine near Hayfork. A shipment of 20 tons of gold quartz ore was made to Selby and about 40 tons were milled at the property in 1949. The gold is associated with pyrite and arsenopyrite. The milling plant includes a gyratory crusher, Chilean mill, 4- by 8-foot copper plate, Knudson bowl and two concentrating tables. Power was obtained from a 35-horsepower gasoline engine.

An access road was built to the Globe mine northeast of Dedrick by M. L. Benoist of Weaverville. He has leased the property from J. A. and W. M. Gilzean of Junction City and is building a small plant to mill the mine dump.

J. A. (Bert) and Warren Gilzean operated the Red Hill hydraulic mine under lease from the Goldfield Consolidated Mines Company in 1949. The gravel is 4 to 10 feet deep and the pit is 70 feet wide and 125 feet long. There are many boulders of gabbro, diorite, and quartzite. The bedrock is hard hornblende schist. Water was brought from Connor Creek and delivered to the monitors under a 300-foot head. Operations were restricted because of a shortage of water. The gold was saved in 100 feet of 36- by 30-inch sluice boxes fitted with steel rail riffles.

The Nugget placer on the East Fork of Stuart Fork 3 miles north of Minersville was operated by O. A. Herbert for a short time starting in April. He leased the dragline and dredge formerly operated by the Thompson Divide Mining Company at that site. The gravel stripped of 5 feet of overburden with a bulldozer, was dug to a depth of about 15 feet to a soft slate bedrock with a dragline equipped with a $1\frac{1}{4}$-yard bucket. The washing plant was built on five steel pontoons making a barge 32 by 40 feet. The trommel was 54 inches in diameter and 22 feet long and included 16 feet of screen. Gold was recovered with Hungarian riffles installed in eight steel cross sluices and three down-stream sluices on each side of the trommel.

In the fall of 1949, machinery and equipment for a slack-line excavator were moved to the south bank of the Trinity River 1.7 miles west of Del Loma by the Oro Del Lomas Company. The gravel is 35 to 40 feet deep and overlies a black schist bedrock. There are many boulders and cobbles at this location. Equipment included a 45-foot mast, a 3-yard bucket, and a double drum hoist. The installation of equipment was not completed in 1949.

The Rex hydraulic mine on Weaver Creek near Weaverville was operated by Perry Bennett during the 1949 season. The gravel is 6 to 12 feet deep in the walls of the pit, there are few boulders, and the bedrock is smooth. Water was taken from the La Grange ditch and delivered to the monitors through 1200 feet of riveted steel pipe under an 80-foot head. The gravel was washed from the bank by two giants fitted with 5-inch nozzles. Gold was saved in 124 feet of 36- by 24-inch sluice boxes fitted with block riffles.

The Swanson Mining Corporation's hydraulic mine at Salyer was operated by the Salyer Syndicate for about 2 months in 1949. The operation was in a lower pit where the gravel and red soil was 40 to 70 feet high and overlay a blue-gray schist bedrock. A monitor fitted with a 6-inch nozzle was used to mine the gravel. The sand and gravel was washed through a rock cut into a 30- by 36-inch metal sluice box 60 feet long, followed by 22 feet of wooden sluice boxes 42 inches wide. The sluices were fitted with rail riffles. The last 5 feet of the sluice was fitted with a manganese steel perforated plate floor, through which the sands dropped into an undercurrent while the oversize slid to the waste dump. The sands were distributed to 32 sluice boxes 18 inches wide and 10 feet long fitted with steel-shod wooden riffles. The black sand concentrates were treated in a 3-cell Peters jig. The jig concentrate included amalgam, gold, and some platinum.

The Bennett dragline dredge was operated by the Uphill Mining Company on Buckeye Creek about 2 miles west of Stringtown for a short time in the spring of 1949. There were many cobbles and boulders at this location, and since the bedrock was too hard to dig with a dragline the operation was terminated April 1. The dredge and equipment were moved to Canyon Creek where the gravel was 4 to 6 feet thick above a greenstone bedrock and included many cobbles of granite, diorite, and hornblende schist. The Lima dragline was equipped with a $1\frac{1}{2}$-yard bucket and the washing plant was built on steel pontoons. Gold was recovered in metal sluice boxes fitted with Hungarian riffles.

The Mires and Garner bucket-line dredge on Coffee Creek was operated by the Western Miners until June 1949. They were succeeded by the

Crescent Gold Dredging Company who operated until November 15. Here the gravel is 18 to 20 feet thick above a soft bedrock and contains many boulders. Gold was saved in the distribution box beneath a trommel, and in eight cross sluices and two downstream sluices on each side. The sluices were fitted with rubber-covered wooden riffles. Electric power was generated by a diesel-driven generator. J.C.O'B.

Tulare County

Natural gas from the Trico field was the principal mineral commodity produced. Crushed rock plants were located at Porterville, Lindsay, and Lemon Cove. Tungsten ore was produced at two mines, one near Lindsay, and one near Orosi.

Mineral Fuels. A substantial volume of natural gas was produced in the Trico gas field, southwestern Tulare County. Here nearly pure methane gas was produced from thin sands in the predominantly clay San Joaquin formation. The low dome from which production was obtained is about 4 miles long by 1½ miles wide; the long axis trending northwest. The field extends southeast into Kern County. The estimated total reserves were 254,709,985 thousand cubic feet,[5] about one-fifth of which has been produced.

Nonmetallic Industrial Materials. The Middletons-Sequoia Rock Company used a power shovel to mine gravel from stream deposits along the south bank of the Kaweah River about 1 mile east of Lemon Cove. Eleven men were employed.

The Terminas Beach Rock Company used a dragline with a 1½-yard bucket to remove gravel from the Kaweah River about 2 miles east of Lemon Cove. Gold recovery facilities were in operation for several months but this part of the plant is now idle because of insufficient gold in the gravel. Twelve men were employed.

The Pacific Coast Aggregates rock plant, 2 miles east of Lindsay, crushed, washed, and sized gravel from a deposit 1½ miles south of the plant. The clay-cemented gravel was mined with a 2½-yard dragline and loaded into a portable truck-loading hopper. The dragline dug to a depth of about 20 feet. Some boulders up to 18 inches in diameter were encountered.

Metals. The Tulare County Tungsten mine, 14 miles northeast of Lindsay, operated continuously until it shut down in April 1949. The tungsten mineral was scheelite, disseminated in tactite. The tactite bodies occurred between granite and masses of crystalline limestone and schist. Ore was mined by underground methods and hauled 1½ miles to the mill. The mill circuit consisted of a jaw crusher, rolls, ball mill, and Wilfley tables. Concentrates from the Wilfley tables were dried, and the magnetic minerals removed before sacking for shipping. Work was resumed in January 1950, but the company planned to shut down again in July 1950. The low price of tungsten, water shortage at the mill, and the requirement that tungsten concentrates contain less than 0.04 percent moblydenum were given as reasons for this mine's inability to operate continuously.

At the Consolidated Tungsten mine near Orosi scheelite mineralization was associated with a small marbleized limestone pendant in granite.

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[5] Bailey, Wm. C., and Barger, Ralph M., Trico gas field: Summary of Operations, California Oil Fields, vol. 32, no. 2, p. 7, 1946.

Much of the marble has been replaced by tactite. Mining and milling was in progress at this mine which produced a low-molybdenum concentrate.
J.W.V.

Tuolumne County

An extremely active and varied phase of the stone industry was centered in Tuolumne County. Marble was mined and quarried in substantial quantities. After screening, the coarse-sized products were burned locally to produce high-calcium and high-magnesium lime. The screenings were used as road aggregate and as a flux in glass-making. At a Sonora plant, terrazzo chips were prepared from colored marble quarried at numerous points throughout the Mother Lode. Road aggregate composed of meta-andesite was made from dump material. Dimension sandstone was quarried from the Ione formation. A number of small lode gold mines along the Mother Lode and in the East Belt were active during the year. Small quantities of silver, lead, zinc, and tungsten were also produced.

Nonmetallic Industrial Materials. The Columbia marble quarries, about 3 miles northeast of Columbia, have been operated under lease by R. E. Maxwell since about 1943. The property contains two quarries, the Upper and the Lower, in dolomitic marble. The main production was from the Lower quarry. Marble was broken to crusher size by primary and secondary blasting and by rock hammers, the broken stone was loaded by a slusher into skips and hoisted along a quarter-mile incline track to a transfer bin at the Upper quarry, and from the transfer bin it was trucked a short distance to a crushing and screening plant. About 100 tons of dolomitic marble were produced daily.

The only lime plant in Tuolumne County was operated by the United States Lime Products Corporation on the south edge of Sonora. Besides buying high-magnesium marble from the Columbia quarries, the company mined high-calcium marble from underground workings at the plant. Stone broken in the mine was slushed directly to primary crushers and then hoisted to the surface. Further crushing and screening yielded large tonnages of finely ground marble which was sold as glass flux. The coarser material was burned to lime in either vertical or rotary kilns, both of which produced high-calcium and high-magnesium lime. The company began to use forced draft, along with high-alumina fire bricks, in the kilns in about 1947. These changes allowed the use of a higher calcining temperature and consequently increased the production capacity of the kilns. To prevent the escape of lime dust into the air, the kiln gases were passed through a multicone precipitator and a water scrubbing tower. Some of the lime was sold as quick-lime and the rest was hydrated.

The Sonora Marble Aggregate Company at Shaws Flat, a few miles north of Sonora, made terrazzo chips from various colors of marble quarried at several places in the Mother Lode counties. White, blue, gray, and ivory marbles were quarried just north of the plant; black marble at Jamestown; green serpentine near Chinese Camp; red and green marble at Waites Corner in Amador County; yellow marble east of Vallecito, Calaveras County; pink rhyolite tuff near Mokelumne Hill, Calaveras County; and green marble at Bagby, Mariposa County. Terrazzo chips in six sizes, ranging from 8 mesh to $\frac{3}{4}$ inch were marketed to makers of both pre-cast and laid-in-place terrazzo. The by-product dust from the plant was largely marketed as agricultural limestone.

Aggregate for road surfacing was produced by Beerman and Jones at their plant 3 miles southwest of Keystone. The plant has been operating since 1937 using rock from the waste dump of the old Rock River shaft of the Hetch Hetchy aqueduct. The rock was mostly meta-andesite from the Jurassic Logtown Ridge formation. Present production is about 25,000 tons of crushed stone a year.

A small quantity of dimension stone was quarried from beds of Ione sandstone by W. E. Yeisley. Mr. Yeisley's quarries north of Cooperstown have been worked since 1948. Commercial grades of the stone were red, yellow, and mixed in color. The plug-and-feather method was used to wedge out the blocks of stone which were hauled to Jamestown and sold for use in garden walls and fireplaces.

Metals. Placer mining for gold in Tuolumne County was limited to a very few small hand operations in 1949, but lode mining was quite active. In the East Belt the tailings dump of the old Golden Star mine near Sawmill Flat was milled and the concentrates shipped to Selby. At the beginning of the year the plant consisted of a 10-ton ball mill and a concentrating table; later a 3-ton ball mill was added. Several other East Belt mines shipped ore including the Grizzley pocket mine near Big Oak Flat, the Longfellow mine, the Morhman mine, and the Two Bettys mine.

The Lucky Strike mine, 1 mile northeast of Tuolumne, is one of the most recent small gold-mine discoveries in the Mother Lode district. It was located in July 1947 and was worked during 1949 by E. H. Crabtree of Tuolumne. The ore contains free gold, with some scheelite and galena, and small quantities of sphalerite. It occurs in quartz veins striking N. 30° E. and dipping 85° E. The ore was hauled about a mile to a small mill where it was crushed in a jaw crusher and a battery of three stamps, and passed over amalgamation plates to a concentrating table.

In the vicinity of Columbia, three lode mines were active. The Ford pocket mines, 3 miles southeast of Columbia, were worked for the entire year and about 200 feet of raises and drifts were driven; the Hidden Treasure mine, near Columbia, was worked under lease by Gibson and Keenan during part of 1949; and the Wind Wheel pocket mine, on the north side of Yankee Hill near Columbia, was active most of the year.

Other lode gold mines active in the Mother Lode district were the Farmington pocket mine at Jamestown, and the Kelley mine near Jacksonville.

M.D.T.

Ventura County

Petroleum and natural gas were the most important mineral products of Ventura County. A well drilled at North Montalvo set a new world's record for depth when it was abandoned at 18,734 feet. Five rock companies were active for 7 months of the year along the Santa Clara River between Montalvo and Santa Paula. Shale was mined near Ventura and processed for the production of light-weight aggregate and building blocks. Gypsum, shell-limestone, and moulding sand were also produced.

Mineral Fuels. Drilling in proved fields continued at a fairly rapid pace. Minor extensions of existing fields were made and deeper pool discoveries were made in the Pirie-Lion Mountain, Rincon, and San Miguelito areas. The Superior Oil Company's well ''Limoneira 1'' broke the world's depth record when it was abandoned in Miocene Delmontian at 18,734 feet. No commercial oil showings were encountered but the project was of significance in testing deep drilling equipment and techniques.

Nonmetallic Industrial Materials. The Montalvo Rock Company plant just west of U. S. Highway 101 produced plaster and concrete sand, crushed rock for plant-mix surfacing ($\frac{1}{2}$ inch minus and $\frac{3}{4}$ inch minus), and five trade sizes of crushed rock. Some rock dust was sold. The gravel pit is about 1 mile up-river from the plant. A power shovel with a 1-yard dipper loaded into trucks, maintaining a 10- to 12-foot bank in the pit. The Saticoy Rock Company plant produced 13 sizes of sand and gravel ranging from plaster sand to $2\frac{1}{2}$- to 3-inch crushed rock. Some rock dust was also sold. The plant had a capacity of about 200 tons per hour.

The entire output of the El Rio Rock Company plant, about 2 miles east of Montalvo, was used in preparing plant-mix surfacing. During 1949 most of the aggregate required was purchased from other producers; their own pit was operated only $3\frac{1}{2}$ months. Two size ranges of aggregate were used, minus $\frac{3}{4}$ inch plus 200-mesh, and minus $1\frac{1}{2}$ inch plus 200-mesh. The aggregate was preheated to 300° or 375° F. before mixing with heated asphalt in a Madson pug mill. This was a batch process, and the plant had a capacity of 150 tons per hour.

The Santa Paula Rock Company and the Independent Rock Company operated near Santa Paula. The Santa Paula plant had a capacity of 125 tons per hour. The Independent Rock Compny produced a few sizes of gravel, plus sand.

The Rocklite Products Company continued to produce a lightweight aggregate from shale at their plant in Ventura. The shale was mined from a hillside quarry with bulldozers and carryall equipment. No blasting was necessary and very little overburden had to be removed. The shale was pushed over a grizzly into a bunker from which it was fed into a roll crusher. The crushed shale was conveyed to vibrating screens and then to raw material bins. Sized products from these bins were fed into three counter-current gas-fired kilns. Two of the kilns were 8 by 125 feet and one was 6 by 90 feet in size. The shale was heated to an approximate temperature of 2000° F. Because of both chemically combined and mechanically held water, the shale expanded approximately 25 percent of its original size. The high temperature reached in the kiln sealed the surface of the rounded, slightly porous shale particles by bringing about incipient fusion of the surface. The hot, expanded shale particles were routed from the kiln through a rotating cooler with water sprays at the lower end. The cooled finished product was sized and stored.

The finished products had the following specifications:

Passing	Retained on	Weight per cubic foot
1 inch	$\frac{9}{16}$ inch	35
$\frac{9}{16}$	$\frac{5}{16}$	43
$\frac{5}{16}$	No. 6-mesh	55
No. 6-mesh	to dust	62

In addition to the production of Rocklite, a masonry products unit was operated, producing many shapes and sizes of concrete blocks using Rocklite aggregate.

Molding sand was produced within the city limits of Ventura by the Ventura Molding Sand Company. The sand occurs as a bed in a section of Pleistocene marine sediments and in places contains shell fragments.

A deposit of shell limestone on the top of Tapo Alto Mountain 5 miles north of Santa Susana was mined by the Western Lime Products Company. The limestone was loaded from a small quarry by a Traxcavator into 5-ton trucks. The trucks hauled a short distance to the mill and dumped over a 10-inch grizzly into a bin feeding a 24-inch Wheeling jaw crusher. The crushed material passed through a rotary kiln drier to a Williams hammer mill in closed circuit with a trommel having 8-mesh openings, and a 6-mesh vibrating screen. The undersize was further screened to produce six sizes, ranging down to 60-mesh. The plant had a capacity of from 100 to 200 tons per day of material which was used for chicken grit, for soil conditioning, and as a fertilizer base.

The Monolith Portland Cement Company mined gypsum from a deposit in Quatal Canyon near the Kern County boundary. A Lima diesel-powered shovel loaded trucks from a hillside quarry. The trucks hauled a short distance to the crushing plant which consisted of a jaw crusher and hammer mill. The crushed product was trucked to Maricopa and shipped by rail to Monolith. R.M.S.

Yolo County

Mining activity in Yolo County during 1949 consisted of the production of sand and gravel from Cache and Putah Creeks. The material was used for building roads and for concrete aggregate.

Nonmetallic Industrial Materials. The Cache Creek Sand and Gravel Company owned and operated by Leroy Kerr of Yolo, mined gravel on the north bank of Cache Creek 2½ miles southwest of Yolo. There were few boulders or cobbles at this location and the material consisted largely of sand, subangular and rounded pebbles of andesite, quartz, and jasper. The sand and gravel was dug to a bed of clay at a maximum depth of 15 feet, using a Bay City dragline fitted with a 1½-yard bucket. Capacity at the washing and screening plant is 300 cubic yards per day.

Frank B. Goodwin and Son operated a sand and gravel pit on the south bank of Cache Creek on land leased from E. E. Sanders. There were no boulders and few cobbles at this location. The material was dug about 7 feet deep with a dragline equipped with a ½-yard bucket.

Parish Brothers, general contractors, obtained sand and gravel from Putah Creek at a point three-fourths of a mile southwest of the Winters Bridge. The gravel was removed to a depth of 6 to 8 feet from a bar about 200 feet wide on the south side of the stream. A dragline fitted with a ¾-yard bucket loaded 5-cubic yard trucks which hauled the gravel 3 miles to a portable Cedar Rapids plant where reduction to minus 1-inch size was made. The product was used as an aggregate in the construction of Highway 40.

Joe Schwarzgruber and his son operated a sand and gravel plant on the south side of Cache Creek about 5 miles northwest of Woodland. A dragline equipped with a ½-yard bucket removed the gravel to a depth of 8 feet where a layer of silt was encountered. The material was washed and screened in a plant adjacent to the pit.

Other gravel operations in the county, which operated intermittently, include the Stephens pit northeast of Esparto on Cache Creek, the Valley Gravel Company, the Winters Gravel Service on Putah Creek, and the Yolo County road department at several places along Cache and Putah Creeks.

J.C.O'B.

Yuba County

Yuba was one of the leading gold-producing counties in the state. Five large bucket-line dredges worked the auriferous deposits in the Yuba Basin, handling enormous tonnages of gravel. The annual payroll of the Yuba Consolidated Gold Fields in California totaled $975,000. Dredge and hydraulic tailings were processed by crushed rock plants to provide aggregate for building and road construction.

Nonmetallic Industrial Materials. The Hallwood gravel plant on the west bank of the Yuba River east of Marysville continued in operation during 1949. The gravel consisted largely of tailings from old hydraulic operations and contained few cobbles over 2 inches in size. The gravel above the black sandy silt contact, at a depth of 6 feet, was removed by a dragline. Some of the gravel was loaded onto trucks and delivered for use in fills, and for building roads and corrals. Most of the material was screened and washed for use as plaster sand, concrete aggregate, and stucco. Cobbles over 1½ inches in size were stock piled and sold as drain rock. The plant can produce 100 yards of washed and screened gravel in 8 hours.

The Marysville Rock Products Company plant on the west bank of the Yuba River east of Marysville was active in 1949. Dry surface gravel was dug with a 12-yard LeTourneau carry-all pulled by a D-8 caterpillar tractor, and screened in a Model 100 Austin-Western portable crushing and screening plant. Most of the product was sold for concrete pipe aggregate.

The Rice Brothers Incorporated sand and gravel plant, located on the north bank of the Yuba River, 8 miles east of Marysville, processed gravel from dredge and hydraulic mine tailings. A dragline with a 1¼-yard bucket removed the gravel to a depth of 12 feet where a layer of clay was encountered. The crushing and screening plant adjacent to the pit has a capacity of 1,000 tons of material in 8 hours. The company also operates a concrete batching plant and a hot oil paving-material plant in Marysville.

The Yuba River Sand Company operated an 8-inch centrifugal sand pump on the Yuba River at Marysville. The pump was mounted on a 25- by 40-foot steel hull built by joining two navy landing barges together. A spiral cutter 31 inches in diameter and 4 feet long, rotating at 14 revolutions per minute, assisted by two jets of water agitated the sand and gravel around the 2-inch suction screen. The pump delivered 2,200 gallons of water per minute containing 10 to 14 percent solids through 450 feet of 8-inch diameter spiral steel pipe to the screening plant. The pipe was floated on navy surplus life rafts and reinforced rubber hose was used in place of elbows. The solid material was 90 percent sand. It was dewatered in classifiers and the oversize was separated into standard concrete aggregate sizes. Some of the $\frac{5}{8}$-inch gravel was crushed in a set of rolls to provide additional sand. Stock piles of concrete aggregate, roofing granules, and plaster, filter and sandblasting-sand were maintained. Production was rated at 100 tons of screened products per hour.

Metals. The Yuba Consolidated Gold Fields operated five bucket-line dredges on the Yuba River between Marysville and Hammonton in 1949. All dredges were equipped with 18-cubic foot buckets and dug gravel at depths ranging from 68 to 124 feet. Large trommel screens, 6 to 9 feet in diameter and 30 to 50 feet long, dropped minus $\frac{5}{8}$-inch material to sluice boxes for gold recovery. Dredges Nos. 19 and 20 were equipped with pulsating jigs to recover the gold. Each dredge averaged 21 hours working time per day, and handled from 3,500,000 to 4,400,000 cubic yards of gravel during the year. Power requirements ranged from 975 to 2,175 horsepower per dredge and operating crews ranged from 22 to 25 men. The Yuba Consolidated Gold Fields employed 250 to 260 men in their Yuba County operations. J.C.O'B.

DIRECTORY OF PRODUCERS OF METALLIC AND NONMETALLIC MINERALS IN CALIFORNIA DURING 1949

(Producers of Natural Gas and Petroleum May Be Found in the Summary of Operations, California Oil Fields, July–Dec. 1949, vol. 35, no. 2, of the State Division of Oil and Gas.)

OPERATOR	ADDRESS	LOCATION
ASBESTOS (TREMOLITE)		MINE
Placer County:		
Joe Delmue & H. Zimdars (Mined but did not ship until 1950)	Forest Hill	Iowa Hill
Shasta County:		
Blas Asbestos Corp	La Moine	La Moine
Powhatan Mining Co	Woodlawn, Baltimore, Md	Castella
BARITE		MINE
Mariposa County:		
Baroid Sales Division, National Lead Co	830 Ducommun St., Los Angeles	El Portal
Plumas County:		
Barium Products Ltd	Box 8A, Newark	Almanor
BORATES		PROPERTY
Inyo County:		
Pittsburgh Plate Glass Co., Columbia Chemical Division	Bartlett	Bartlett
United States Borax Co	510 W. Sixth St., Los Angeles 14	Shoshone
Kern County:		
Pacific Coast Borax Co	510 W. Sixth St., Los Angeles 14	Boron
San Bernardino County:		
American Potash and Chemical Corp	3030 W. Sixth St., Los Angeles 54.	Trona
West End Chemical Co	608 Latham Square Bldg., Oakland 12	Westend
BROMINE		PROPERTY
Alameda County:		
Westvaco Chemical Div., Food Machinery & Chemical Corp	405 Lexington Ave., New York 17, N.Y.	Newark

OPERATOR	ADDRESS	LOCATION
San Bernardino County:		
American Potash and Chemical Co.	3030 W. Sixth St., Los Angeles 54.	Trona
CALCIUM CHLORIDE		MINE
San Bernardino County:		
California Rock Salt Co.	2436 Hunter St., Los Angeles 21	Amboy
Desert Properties Co., Frank Thomas, Receiver	374 Court St., Rm. 11, San Bernardino	Amboy
Hill Brothers Chemical Co.	2159 Bay St., Los Angeles 21	Amboy
CARBON DIOXIDE GAS		WELL
Imperial County:		
Cardox Western, Inc	151 N. Avenue 19, Los Angeles 31	Niland
Mendocino County:		
Caldri Ice Corp.	Old River Road, Hopland	Hopland
CEMENT		MILL
Calaveras County:		
Calaveras Cement Co.	315 Montgomery St., San Francisco 6	San Andreas
Kern County:		
Monolith Portland Cement Co.	215 W. Seventh St., Los Angeles 14	Monolith
Los Angeles County:		
Blue Diamond Corp.	1650 S. Alameda St., Los Angeles 54	Los Angeles
Riverside County:		
Riverside Cement Co.	621 Hope St., Los Angeles 17	Crestmore
San Benito County:		
Pacific Portland Cement Co.	417 Montgomery St., San Francisco 6	San Juan Bautista

OPERATOR	ADDRESS	LOCATION
San Bernardino County:		
California Portland Cement Co.	612 S. Flower St., Los Angeles 14	Colton
Riverside Cement Co.	621 S. Hope St., Los Angeles 17	Oro Grande
Southwestern Portland Cement Co.	1034 Wilshire Blve., San Francisco 14	Victorville
San Mateo County:		
Pacific Portland Cement Co.	417 Montgomery St., San Francisco 6	Redwood City
Santa Clara County:		
Permanente Cement Co.	Permanente	Permanente
Santa Cruz County:		
Santa Cruz Portland Cement Co.	324 Crocker Bldg., San Francisco 4	Davenport
CLAY (Including producers of crude clay; and manufacturers of brick, tile, and other heavy clay products.)		PLANT OR PIT
Alameda County:		
California Pottery Co. (Clay products, crude clay)	P.O. Box 68, Niles	Niles
California Rock & Gravel Co. (Crude clay)	1800 Hobert Bldg., San Francisco	Eliot
N. Clark & Sons Division, Pacific Clay Products Co. (Clay products, brick and hollow building-tile)	Box 145, Sta. A, Los Angeles 31	Alameda
Gladding, McBran & Co. (Brick and hollow building-tile, crude clay)	2901 Los Feliz Blvd., Los Angeles 26	Altamont, Livermore
Interlocking Roof Tile Co. (Clay products, crude clay)	Box 488, Niles	Niles
Kraftile Co. (Clay products, brick and hollow building-tile, crude clay)	Niles	Niles
M. & S. Tile Co. (Clay products, crude clay)	2nd & E Sts., Decoto	Decoto

OPERATOR	ADDRESS	LOCATION
Amador County:		
N. Clark & Sons Division, Pacific Clay Products Co. (Crude clay)	P.O. Box 145, Sta. A, Los Angeles 31	Ione
Gladding, McBean & Co. (Crude clay)	2901 Los Feliz Blvd., Los Angeles 26	Ione
Western Refractories Co. (Brick and hollow building-tile, crude clay)	Box 169, Ione	Ione
Calaveras County:		
California Pottery Co. (Crude clay)	P.O. Box 68, Niles	Valley Springs
Pacific Clay Products Co. (Crude clay)	P.O. Box 145, Sta. A, Los Angeles 31	Valley Springs
Contra Costa County:		
American Radiator & Standard Sanitary Mfg. Co., (Clay products)	Box W, Richmond	Richmond
California Art Tile Corp. (Clay products)	Box 1116, Richmond	Richmond
Gladding, McBean & Co., (Brick and hollow building-tile)	2901 Los Feliz Blvd., Los Angeles 26	Pittsburg
Port Costa Brick Works, C.G. Berg, Pres., (Brick and hollow building-tile, crude clay)	411 Berry St., San Francisco	Port Costa
Technical Porcelain & Chinaware Co. (Clay products)	Manila and Kearney Sts., El Cerrito	El Cerrito
United Materials & Richmond Brick Co., Ltd., (Clay products, brick and hollow building-tile)	Box 7, Point Richmond	Richmond
Fresno County:		
Craycroft Brick Co. (Clay products, brick and hollow building-tile, crude clay)	P.O. Box 814, Fresno	Fresno
Humboldt County:		
Hindley Clay Products (Clay products, brick and hollow building-tile, crude clay)	3121 Essex St., Eureka	Cutten

OPERATOR	ADDRESS	LOCATION
Inyo County:		
Sierra Talc Co. (Filtering clay and bentonite)	5509 Randolph Ave., Los Angeles	Olancha
Kern County:		
Aetna Mines Corp. (Filtering clay and bentonite)	Suite 416 National Bldg., 166 W 3rd St., Los Angeles 12	Inyokern
American Mineral Co. (Crude clay)	2770 E. Eighth St., Los Angeles 23	Cantil
Bakersfield Sandstone Brick Co. (Brick and hollow building-tile)	315 E. 18th St., Bakersfield	Bakersfield
Excel Minerals Co. (Filtering clay and bentonite)	115 La Verne Ave., Pomona	McKittrick
Kernco Materials Co. (Oil-well drilling mud)	1916 Radiance Dr., Bakersfield	Muroc
Macco Corp., Drilling Mud Div. (Oil-well drilling mud)	14409 S. Paramount Blvd., Paramount	Rosamond
McKittrick Mud Co. (Oil-well drilling mud).	Box 356, McKittrick	McKittrick
Mojave Corp. (Oil-well drilling mud)	P O. Box 174, Los Nietos	Muroc
Taft E. Werner Co. (Crude clay)	P.O. Box 316 Rosamond	Lancaster
Los Angeles County:		
American Container Co. (Clay products)	3132 Washington Blvd., Los Angeles 23	Los Angeles
Angulo Tile Co. (Clay products, crude clay)	19044 Kittridge St., Reseda	Reseda
Atkinson Brick Co. (Brick and hollow building-tile, crude clay)	13633 Central Ave., Los Angeles 2.	Los Angeles
Atlas Sewer Pipe Co. (Clay products, crude clay)	10009 S. Painter St., Whittier	Whittier
B. & W. Tile Mfg. Co. (Clay products)	14600 S. Western Ave., Gardena	Gardena
J.A. Bauers Pottery Co. (Clay products)	415 W. Ave. 33, Los Angeles 31	Los Angeles
J.C. Booth (Clay products, crude clay)	1775 Stanford Ave., Santa Monica	Santa Monica
Builders Brick Co. (Brick and hollow building-tile, crude clay)	P.O. Box 266, Gardena	Compton
Castaic Co. (Brick and hollow building-tile, crude clay)	Castaic	Castaic
H.F. Coors Co., Inc. (Clay products)	Inglewood	Inglewood
Coast Brick Co. (Brick and hollow building-tile, crude clay)	17720 Prairie Ave., North Torrance via Torrance	North Torrance

OPERATOR	ADDRESS	LOCATION
Davidson Brick Co. (Brick and hollow building-tile, crude clay)	4701 Floral Dr., Los Angeles 22	Los Angeles
General Refractories Co. (Brick and hollow building-tile)	3363 Fruitland Rd., Los Angeles	Los Angeles
Gladding, McBean & Co., Tropico, L.A. & S.M. Plants (Clay products, brick and hollow building-tile, crude clay)	2901 Los Feliz Blvd., Los Angeles 26	Tropico, Los Angeles, Santa Monica, Pico.
Higgins Brick & Tile Co. (Brick and hollow building-tile, crude clay)	P.O. Box 1125, Sta. A, Gardena	Moneta
Italian Terra Cotta Co. (Clay products)	1149 Mission Rd., Los Angeles	Los Angeles
Lynn Brick Co. (Brick and hollow building-tile crude clay)	Normandie & Pacific Coast Hwy., Harbor City	Harbor City
Pacific Brick Co. (Brick and hollow building-tile, crude clay)	P.O. Box 1125, Sta. A, Gardena	Santa Monica
Pacific Clay Products (clay products, brick and hollow building-tile, crude clay)	Box 145, Sta. A, Los Angeles 31	Los Angeles and Los Nietos
Pacific Tile & Porcelain Co. (Clay products)	P.O. Box 638, Hynes	Hynes
Pomona Brick Co., S. Bernard Strona (Brick and hollow building-tile, crude clay)	Ninth and Buena Vista, Pomona	Pomona
Pomona Tile Mfg. Co. (Clay products)	629 N. La Brea Ave., Los Angeles	Pomona
St. Louis Fire Brick and Insulation Co. (Brick and hollow building-tile)	3050 E. Slauson St., Huntington Park	Huntington Park
San Valle Tile Kilns (Clay products, crude clay)	1258 N. Highland Ave., Los Angeles 38	Reseda
Simons Brick Co., (Brick and hollow building-tile, crude clay)	1195 S. Boyle Ave., Los Angeles 23	Los Angeles
Southwest Brick Co. (Brick and hollow building tile, crude clay)	17601 S. Western Ave., Gardena	Gardena
Valley Brick & Supply Co. (Brick and hollow building-tile, crude clay)	6151 Kester Ave., Van Nuys	Van Nuys
Vernon Kilns (Clay products)	2300 E. 52nd St., Los Angeles	Vernon
Marin County:		
McNear Brick Co. (Clay products, brick and hollow building-tile, crude clay)	McNear Point, San Rafael	McNear

OPERATOR	ADDRESS	LOCATION
Orange County:		
El Toro Clay Co., I.P. Arnold (Crude clay, filtering clay and bentonite)............	7655 E. Second St., Downey, Los Angeles...........................	El Toro...........
Gladding, McBean & Co. (Crude clay).........	2901 Los Feliz Blvd., Los Angeles 26	Irvine, Claymont, Prado.............
La Bolsa Tile Co. (Clay products, crude clay)	R.F.D. 18404 Gothard St., Huntington Beach..........................	Smeltzer..........
Placer County:		
Gladding, McBean & Co. (Clay products, brick and hollow building-tile, crude clay).....	2901 Los Feliz Blvd., Los Angeles 26	Lincoln...........
Lincoln Clay Products Co. (Crude clay)......	P.O. Box 367, Lincoln............	Lincoln...........
Riverside County:		
Alberhill Coal & Clay Co. (Crude clay)......	Box 4267, Village Sta., Los Angeles 24..............................	Alberhill.........
Los Angeles Brick & Clay Products Co. (Clay products, brick and hollow building-tile, crude clay)............................	1078 N. Mission Rd., Los Angeles 54	Alberhill.........
Pacific Clay Products (Crude clay)..........	Box 145, Sta. A, Los Angeles 31...	Corona............
Temescal Clay Co. (Crude clay).............	Suite 309-6308 Pacific Blvd., Huntington Park.....................	Temescal..........
Sacramento County:		
California Art Tile Corp. (Crude clay)......	Box 1116, Richmond...............	Natoma............
Cannon & Co. (Clay products, brick and hollow building-tile, crude clay)...............	Box 802, Sacramento 4............	Ben Ali and Michigan Bar...............
Gladding Bros., Mfg. Co. (Crude clay).......	S. Third and Keyes St., San Jose 12	Folsom............
Harrison Fait (Crude clay).................	1950 Howe Ave., North Sacramento..	N. Sacramento.....
H.C. Muddox, Jessie E. Muddox, Owner (Clay products)................................	30th and L Sts., Sacramento.......	Sacramento.........
Sacramento Brick Co. (Brick and hollow building-tile, crude clay)...............	1300 Front St., Sacramento 4......	Sacramento.........

OPERATOR	ADDRESS	LOCATION
San Benito County:		
San Benito Bentonite Co. (Filtering clay and bentonite)............................	111 Brookside Ave., San Jose.......	Tres Pinos..........
San Bernardino County:		
Baroid Sales Div., National Lead Co.. (Oil well drilling mud, filtering clay and bentonite.	P.O. Box 2558 Ter. Annex. St., Los Angeles 54.......................	Hector..............
Gladding, McBean & Co. (Crude clay)........	2901 Los Feliz Blvd., Los Angeles 26	Goff................
Hancock Brick Yard, C.P. Hancock & Son (Brick and hollow building-tile, crude clay)....	Box 421, Riverside...............	Highgrove...........
Inerto Co. (Filtering clay and bentonite)..	1489 Folsom St., San Francisco....	Newberry............
Marter Mining Co. (Crude clay)............	530 W. Sixth St., Los Angeles 14..	Bryman..............
Louis Martinez (Filtering clay and bentonite)	Box 374, Red Mountain............	Red Mountain........
Southern California Minerals Co., W.K.Skeoch (crude clay)...........................	320 S. Mission Rd., Los Angeles 33	Goff................
Taft E. Warner Co. (Oil-well drilling mud).	P.O. Box 316, Rosamond..........	Barstow............
San Diego County:		
La Jolla Canyon Clay Products (Clay products, crude clay)............................	P.O. Box 712, La Jolla..........	La Jolla...........
Union Brick Co. (Brick and hollow building-tile, crude clay)......................	P.O. Box 356, San Diego 9........	Rose Canyon.........
Vitrified Products (Clay products, crude clay)	4570 Pacific Highway, San Diego 10	San Diego..........
San Joaquin County:		
Laurel Potteries (Clay products)..........	McKinley Ave., Stockton..........	Stockton...........
Pacific Clay Products Co. (Clay products, crude clay)..............................	Box 145, Station A, Los Angeles 26	Stockton...........
San Joaquin Brick Co. (Brick and hollow building-tile).........................	P.O. Box 387, Stockton 4........	Roberts Island......
Stockton Brick & Tile Co. (Clay products)..	P.O. Box 547, Stockton..........	Stockton...........
San Luis Obispo County:		
San Luis Brick Works (Brick and hollow building-tile, crude clay)...................	2900 S. Broad St., San Luis Obispo	San Luis Obispo.....

OPERATOR	ADDRESS	LOCATION
Santa Barbara County:		
McNall Building Materials (Clay products, brick and hollow building-tile)..........	P.O. Box 758, Santa Barbara........	Santa Barbara......
Santa Clara County:		
A.D. Bernal (Crude clay)..................	San Jose.........................	San Jose...........
Garden City Pottery (Clay products)........	560 N. Sixth St., San Jose........	San Jose...........
Gladding Bros. Mfg. Co. (Clay products, brick and hollow building-tile, crude clay)....	S. Third and Keyes Sts., San Jose 12	San Jose...........
Myers Ceramic Pottery (Clay products)......	Box 97, Santa Clara...............	Santa Clara........
Remillard-Dandini Co. (Brick and hollow building-tile, crude clay)....................	321 13th St., Oakland.............	San Jose...........
San Jose Brick & Tile Co. (Brick and hollow building-tile, crude clay)..............	1440 Broadway, Rm. 701, Oakland 12	San Jose...........
Stanislaus County:		
Harry Chase (Crude clay)..................	Knights Ferry.....................	Knights Ferry......
Lester Raggio (Crude clay)................	Knights Ferry.....................	Cooperstown........
Sutter County:		
Gladding, McBean & Co. (Crude clay)........	2901 Los Feliz Blvd., Los Angeles 26	Nicolaus...........
Tulare County:		
West Coast Minerals, Inc. (Crude clay).....	1930 Wilshire Blvd., Los Angeles 5	Ducor..............
Ventura County:		
Rocklite Products (Crude clay)............	1800 N. Ventura Ave., Ventura....	Ventura............
Shell Oil Co., Dent Clay Pit (Oil-well drilling mud)................................	Shell Bldg., San Francisco.......	Ventura............
Tide Water Associated Oil Co. (Crude clay).	79 New Montgomery St., San Francisco	Ventura............
COAL		MINE
Amador County:		
American Lignite Products Co...............	Ione..............................	Ione...............

OPERATOR	ADDRESS	LOCATION
DIATOMITE (DIATOMACEOUS EARTH)		MINE OR QUARRY
Inyo County:		
Hazen Mining Co.	Independence	Zurich
Los Angeles County:		
Great Lakes Carbon Corp., Dicalite Division	612 S. Flower St., Los Angeles 14.	San Pedro
Santa Barbara County:		
Johns-Manville Products Corp.	22 E. 40th St., New York 16, N.Y.	Lompoc
DOLOMITE		QUARRY
Inyo County:		
Dolomite Products Inc.	510 W. Garfield, Glendale 4	Lone Pine
Monterey County:		
Permanente Metals Corp. (name changed to Kaiser Aluminum and Chemical Corp. on Nov. 28, 1949)	P.O. Box 1531, Salinas	Natividad
San Benito County:		
Westvaco Chemical Division, Food Machinery & Chemical Corp.	Box 8A, Newark	Hollister
San Bernardino County:		
Marter Mining Co.	530 W. Sixth St., Los Angeles 14.	Thorn
Tuolumne County:		
U.S. Lime Products Corp.	1840 E. 25th St., Los Angeles 25	Sonora
FELDSPAR		MINE
Madera County:		
Almyra S. Anderson	Rt. 1, Box 134, Fresno 4	Friant
San Bernardino County:		
Gladding, McBean & Co.	2901 Los Feliz Blvd., Los Angeles 26	Atolia

OPERATOR	ADDRESS	LOCATION
GRANITE		QUARRY
Fresno County:		
Superior-Academy Granite Co	Box 68, Clovis	Academy
Lassen County:		
Greig Quarry, J.B. Wagender	805 Weatherlow St., Susanville	Susanville
Los Angeles County:		
H.A. Jones, et al	215 W. Green St., Pasadena	Saugus
Placer County:		
Union Granite Co	Rocklin	Rocklin
Riverside County:		
Emil Johnson & Son	Rt. 2, Box 185, Escondido	Perris
San Bernardino County:		
W.H. Johnson & Co	Victorville	Victorville
San Diego County:		
California Black Granite Co	Rt. 1, Box 248J, Escondido	Twin Oak Valley
California Cut Stone & Granite Works	Railroad Ave. at Magnolia, South San Francisco	Vista
Fred B. Clemens	3460 Imperial Ave., San Diego 2	Suncrest
Crystal Black Quarry, John Stridsburg	Box 115, Escondido	Spooks Canyon
Lakeside Silver Gray Granite Co	Lakeside	Lakeside
National Quarries	Rt. 2, Box 185, Escondido	Escondido & Fall Brook
Pacific Cut Stone & Granite Co	414 S. Marengo Ave., Alhambra	Escondido
Southern California Granite Co	3845 Imperial Ave., San Diego 2	Foster
Valley Granite Co., W. T. Blackwood & Son.	243 E. Fifth St., Escondido	Escondido

OPERATOR	ADDRESS	LOCATION
San Luis Obispo County:		
R.A. Mora	358 N. Broad St., San Luis Obispo.	San Luis Obispo
Sonoma County:		
S. Cabrol	Rt. 1 Box 115, Glen Ellen	Glen Ellen
GYPSUM		QUARRY
Alameda County:		
Westvaco Chemical Division, Food Machinery & Chemical Corp. (Output not included in production figures as gypsum is by-product of chemical process using minerals already included in state total)	405 Lexington Ave., New York, N.Y.	Newark
Fresno County:		
Agricultural Mineral & Fertilizer Co., A.D. Sousa	P O. Box 832, Los Banos	Los Banos
John K. Griffin	270 Upland Dr., San Francisco 27..	Tumey Gulch
Super Gypsum Mine	P.O. Box 66, Chowchilla	Dos Palos
Valley View Gypsum Mine	Rt. 4, Box 221, Madera	Firebaugh
Imperial County:		
U.S. Gypsum	300 W. Adams St., Chicago 6, Ill..	Plaster City
Kern County:		
Carrisa Gypsum Mine, C.L. Fannin	Rt. 1, Box 7, Wasco	Wasco
H.M. Holloway	Box 310, Lost Hills	Lost Hills
McKittrick Agricultural Gypsum Co	McKittrick	McKittrick
Pacific Gypsum Co	P.O. Box 563, Bakersfield	Conner
Western Gypsum Co., J.W. Vils	733 Maple St., Wasco	McKittrick
Kings County:		
H.M. Holloway	Box 310, Lost Hills	Avenal

OPERATOR	ADDRESS	LOCATION
Riverside County:		
United States Gypsum Co.	300 W. Adams St., Chicago, Ill.	Midland
Utah Construction Co.	1 Montgomery St., San Francisco	Inca Siding
San Bernardino County:		
Peg Leg Mine, I.A. Himes	Star Rt. 1, Barstow	Barstow
San Luis Obispo County:		
C.E. Vanderford Gypsum Mine	P.O. Box 145, Delano	Shandon
Ventura County:		
Monolith Portland Cement Co.	215 W. Seventh St., Los Angeles 14	Quatal Canyon
IODINE		WELL
Los Angeles County:		
Deepwater Chemical Co., Ltd.	Box 588, Compton	Compton
The Dow Chemical Co.	Midland, Michigan	Long Beach, Venice, and Seal Beach
LIME, LIMESTONE, AND SHELLS		QUARRY
Alameda County:		
Westvaco Chemical Division, Food Machinery & Chemical Corp. (Producer of burnt lime, shells)	405 Lexington Ave., New York, N Y.	Newark
El Dorado County:		
California Rock & Gravel Co. (Industrial limestone)	1800 Hobart Bldg., San Francisco	Newcastle
Diamond Springs Lime Corp. (Producer of burnt lime, industrial limestone, agricultural lime)	Box 409, Diamond Springs	Diamond Springs

OPERATOR	ADDRESS	LOCATION
El Dorado Limestone Co., J.H. Bell, Pres., (Industrial limestone)	Shingle Springs	Shingle Springs
Hughes-Vertin Lime Co. (Producer of burnt lime, industrial limestone, used in rough construction)	Box 231, Auburn	Newcastle
Fresno County:		
Soil Materials & Fertilizer, Mrs. E.R. Colvin (Agriculture lime, marl)	4805 Harvey, Fresno	Minkler
Inyo County:		
Blue Star Mines, Ltd. (Industrial limestone)	667 S. Anderson, Los Angeles 23	Zurich
Monterey County:		
The Permanente Metals Corp. (Name changed to Kaiser Aluminum & Chemical Corp. on November 28, 1949) (Producer of burnt lime)	P.O. Box 1531, Salinas	Moss Landing
San Bernardino County:		
Cal. Portland Cement Co. (Producer of burnt lime, industrial limestone)	612 S. Flower St., Los Angeles 14.	Colton
Chubbuck Lime Co., Charles I. Chubbuck, (Producer of burnt lime, industrial limestone, agricultural lime)	4711 Worth St., Los Angeles 33	Chubbuck
Marter Mining Co. (Industrial limestone)	530 W. Sixth St., Los Angeles 14	Lucerne Valley
Victorville Lime Rock Co. (Industrial limestone)	Box 548, Victorville	Victorville
West End Chemical Co. (Producer of burnt lime, industrial limestone)	608 Latham Sq., Oakland 12	Westend

OPERATOR	ADDRESS	LOCATION
San Luis Obispo County:		
Essential Industries Inc., (Industrial limestone)	550 Russ Bldg., San Francisco 4	Cambria
San Mateo County:		
Pacific Portland Cement Co. (Agricultural lime, shells)	417 Montgomery St., San Francisco	Redwood City
Rockaway Quarry, Inc. (Crushed limestone).	340 Pine St., San Francisco 4	Rockaway Beach
Ken Royce, Inc. (Crushed limestone)	185 Bayshore Blvd., San Francisco 24	Rockaway Beach
Santa Clara County:		
Bay Shell Co. (Agricultural lime, shells).	503 Market St., San Francisco	Alviso
Permanente Cement Co. (Industrial limestone)	Permanente	Permanente
Santa Cruz County:		
Pacific Limestone Prod. Co. (Industrual limestone, agricultural lime)	Spring St., Santa Cruz	Santa Cruz
Santa Cruz Portland Cement Co. (Industrial limestone)	Crocker Bldg., San Francisco 4	Davenport
Tuolumne County:		
Sonora Marble Aggregates Co. (Industrial limestone)	356 Church St., San Francisco	Sonora
U.S. Lime Products Corp., (Producer of burnt lime, industrial limestone, agricultural lime)	1840 E. 25th St., Los Angeles 11	Sonora
Ventura County:		
Western Lime Products Co. (Industrial limestone, agricultural lime)	6305 Yucca St., Los Angeles	Santa Susana

OPERATOR	ADDRESS	LOCATION
LITHIA		MINE
San Bernardino County:		
American Potash & Chemical Corp.	3030 W. Sixth St., Los Angeles 54.	Trona
MAGNESIA AND OTHER MAGNESIUM COMPOUNDS		PLANT
Alameda County:		
Pabco Products Inc. (Carbonate)	1550 Powell St., Emeryville 8	Emeryville
Westvaco Chemical Division, Food Machinery & Chemical Corp. (Oxide)	405 Lexington Ave., New York 17, N.Y.	Newark
Monterey County:		
The Permanente Metals Corp. (name changed to Kaiser Aluminum & Chemical Corp., in November, 1949) (Oxide)	P.O. Box 1531, Salinas	Moss Landing
San Diego County:		
Westvaco Chemical Division, Food Machinery & Chemical Corp. (Chloride)	405 Lexington Ave., New York 17, N.Y.	Chula Vista
San Mateo County:		
Johns-Manville Products Corp. (Basic carbonate)	22 E. 40th St., New York 16, N.Y.	Redwood City
Marine Magnesium Prod.Corp., R.E. Clarke (Carbonate, hydroxide, and oxide)	South San Francisco	South San Francisco.
MAGNESITE		MINE
Santa Clara County:		
Westvaco Chemical Division, Food Machinery & Chemical Corp.	405 Lexington Ave., New York 17, N.Y.	Red Mountain

OPERATOR	ADDRESS	LOCATION
MINERAL PIGMENTS, NATURAL		PROPERTY
San Bernardino County:		
Rowe, Mullinix and Buehler	1555 Sunset Ave., Pasadena 3	Ludlow
PEAT		BOG
Contra Costa County:		
California Peat Co	P.O. Box K, Antioch	Antioch
Modoc County:		
Modoc Peat Moss Co	604 Mission St., San Francisco	Likely
Orange County:		
Lawrence P. Kraemer	Box P, Placentia	Westminster
San Diego County:		
Growers Peat Humus Co	P.O. Box 486, Oceanside	Oceanside
PEBBLES FOR GRINDING		PIT
San Diego County:		
Crystal Silica Co	717 E. 61st St., Los Angeles	Encinitas Beach
POTASH		PLANT
San Bernardino County:		
American Potash and Chemical Co	3030 W. Sixth St., Los Angeles 54	Trona
PUMICE AND VOLCANIC ASH		PROPERTY
Amador County:		
Chas. Bacon (Pumicite or volcanic ash)	Ione	Carbondale
Lava Products Co., Robert Irvine (Pumicite or volcanic ash)	3010 Colbey St., Berkeley	

OPERATOR	ADDRESS	LOCATION
Calaveras County:		
Brownlite Products, Harry Brown (Pumice)	701 Laurel St., Modesto	Valley Springs
Imperial County:		
Superlite Corp. Morris Butterfield (Pumice)	P.O. Box 758, Calipatria	Calipatria
Inyo County:		
Desert Materials Corp. (Pumice)	6371 Wilshire Blvd., Los Angeles 36	Inyokern
H.B. Jarvis (Pumice)	P.O. Box 5, Little Lake	Little Lake
W.W. Pumice Co., Wm. Wainscott (Pumice)	4040 Wilshire Blvd., Los Angeles	Dumnovin
Western Talc Co. (Pumicite or volcanic ash)	1901 E. Slauson Ave., Los Angeles 11	Shoshone
H.A. Van Loon(Pumicite or volcanic ash)	Bishop	Bishop
Kern County:		
Insulpum Corp. (Pumice)	P.O. Box 451, Mojave	Cantil
Madera County:		
California Industrial Mineral Co. Forrest F. Taylor (Pumicite or volcanic ash)	P.O. Box 188, Friant	Friant
Elmer Erickson (Pumice)	Star Rt., Box 1, Fresno 7	Friant
Modoc County:		
Boorman Pumice Products (Pumice)	Tionesta	Tionesta
Glass Mt. Brick Co. (Pumice)	Box 10, Star Rt. 2, Tulelake	Glass Mountain
Glass Mt. Volcolite Co., H.W. Free (Pumice)	Tionesta	Glass Mountain
Mono County:		
Insulating Aggregate Co., G.M.M. Grant, (Pumice)	Bishop	Laws
U.S. Pumice Supply Co. (Pumice, scoria)	5509 Randolph St., Los Angeles 22.	Leevining
H.A. Van Loon (Pumice)	Bishop	Benton

OPERATOR	ADDRESS	LOCATION
Napa County:		
Basalt Rock Co. (Pumice)	P.O. Box 540, Napa	Napa
Pearl Pumice Co., John Q. Pearl (Pumice)	2186 Monticello Rd., Napa	Napa
Walker Pumice Co., D.C. Walker, (Pumice)	Monticello Rd., Napa	Napa
San Bernardino County:		
Western Talc Co. (Pumice)	1901 E. Slauson Ave., Los Angeles 11	Yermo
Siskiyou County:		
Boorman Pumice Products (Pumice)	Tionesta	Glass Mountain
Glass Mt. Industries(Pumice, scoria)	P O. Box 766, Klamath Falls, Ore.	Glass Mountain
Glass Mt. Volcolite Co., H.W. Free (Pumice, scoria)	Tionesta	Glass Mountain
John Madsen, (Skoria Star Brick Co.) (Pumice, scoria)	P.O. Box 711, Klamath Falls, Ore.	Glass Mountain
Thompson Pumice Co. (Pumice)	Tionesta	Glass Mountain
Stanislaus County:		
Base Material Co., R.W. Lepper (Pumicite or volcanic ash)	Crows Landing	Newman
PYRITE		MINE
Orange County:		
Old Dominion Mine, Earl Trevert	218 E. 2nd St., Santa Ana	Elsinore
Shasta County:		
The Mountain Copper Co., Ltd., L.T.T. Kett, Mgr	216 Pine St., San Francisco	Matheson

OPERATOR	ADDRESS	LOCATION
SALT		PLANT
Alameda County:		
American Salt Co	341 Broadway, San Francisco 11	Mt. Eden
Leslie Salt Co	310 Sansome St., San Francisco	Newark and Mt. Eden
Morton Salt Co	310 S. Michigan Ave., Chicago, Ill.	Newark
Oliver Bros. Salt Co	Mt. Eden	Mt. Eden
Kern County:		
Long Beach Salt Co	2476 Hunter St., Los Angeles 21	Saltdale
Mono County:		
C.C. Miller	13623 E. Los Angeles St., P.O. Box 365, Baldwin Park	Leevining
Monterey County:		
Monterey Bay Salt Works, E.C. Vierra, Mgr.	Box 43, Moss Landing	Moss Landing
Orange County:		
The Irvine Co	Box B, Tustin	Newport Beach
San Bernardino County:		
California Rock-Salt Co	2436 Hunter St., Los Angeles 21	Amboy
Dale Chemical Industries, Inc	4031 Goodwin Ave., Los Angeles 21.	Twenty-nine Palms
San Diego County:		
Western Salt Co	1245 National Ave., San Diego	Chula Vista
San Mateo County:		
Leslie Salt Co	310 Sansome St., San Francisco	Redwood City

OPERATOR	ADDRESS	LOCATION
SAND, GRAVEL, AND STONE, MISCELLANEOUS		PIT OR QUARRY
Alameda County:		
Bell Sand & Gravel, Stanley L. and Anna L. Bell (Sand and gravel).................	P.O. Box 282, Irvington..........	Irvington........
California Rock & Gravel Co. (Sand and gravel)	1800 Hobart Bldg., San Francisco..	Livermore........
Deetz Sand & Gravel Co., H J. Deetz (Sand and gravel).........................	Pleasanton......................	Pleasanton.......
Heafey-Moore Co., Div. Gallagher & Burk Inc. (Crushed rock - macadam, ballast, rubble, riprap, etc.)........................	344 High St., Oakland............	Oakland..........
Inland Aggregates Co., Inc. (Sand and gravel)	P.O. Box 236, Niles..............	Niles............
Henry J. Kaiser Co. (Sand and gravel, crushed rock - macadam, ballast, rubble, riprap, etc.)..................................	Kaiser Bldg., 1924 Broadway, Oakland	Radum............
Leslie Salt Co. (Crushed rock - Macadam, ballast, rubble, riprap, etc.)............	310 Sansome St., San Francisco.....	Newark...........
J.L. Martin (Crushed rock - macadam, ballast, rubble, riprap, etc.)..................	5921 Shepherd Canyon Rd., Oakland..	Oakland..........
Niles Quarry Co. (Crushed rock - macadam, ballast, rubble, riprap, etc.)..........	Box 507A, 4061 Highland Blvd., Niles	Niles............
Pacific Coast Aggregates, Inc. (Sand and gravel, crushed rock - macadam, ballast, rubble, riprap, etc.)..................	400 Alabama St., San Francisco....	Eliot and Centerville
San Leandro Rock Co. (Crushed rock - macadam, ballast, rubble, riprap, etc.)..........	1575 Lake Chabot Rd., San Leandro.	Lake Chabot........
W.C. Thompson Inc. (Concrete Materials Co.) (Sand and gravel)......................	1401 Illinois St., San Francisco..	Pleasanton.........
A.C. Zaro (Sand and gravel)..............	Box 323, Pleasanton..............	Pleasanton.........
Amador County:		
Chas. Ayres (Sand and gravel)............	P.O. Box 266, Sutter Creek........	Sutter Creek.......

OPERATOR	ADDRESS	LOCATION
Butte County:		
Butte Creek Rock Co. (Sand and gravel).....	Centerville Rd., Chico...........	Chico.............
Henry J. Kaiser Co. (Sand and gravel, crushed rock -macadam, ballast, rubble, riprap, etc.)..................................	1924 Broadway, Oakland...........	Oroville..........
Kemen Gravel Pit, C.J. Kemen (Sand and gravel)	Paradise.........................	Paradise..........
Calaveras County:		
Neilsen Sand & Gravel Co. (Sand and gravel)	Box 14, San Andreas..............	San Andreas........
Colusa County:		
Cortina Sand, Gravel and Silt; Gene Godin (Sand and gravel).......................	Colusa...........................	Colusa.............
Contra Costa County:		
Antioch Sand Co. (Sand and gravel)........	1806 30th Ave., San Francisco 22..	Antioch...........
Basalt Rock Co. (Sand and gravel).........	Eighth and River Sts., Napa.......	Antioch...........
Blake Bros., Anson Blake (Crushed rock -macadam, ballast, rubble, riprap, etc.)....	Box 1002, Richmond...............	Point Richmond.....
Henry J. Kaiser Co. (Sand and gravel, crushed rock -macadam, ballast, rubble, riprap, etc.).................................	1924 Broadway, Oakland...........	Antioch...........
Marchio Sand Co. (Molding sand)..........	Antioch..........................	Antioch...........
Morris Sand Pit, Ben Morris (Sand and gravel)	R.F.D. Box 100, Antioch..........	Antioch...........
Roberts Sand Co. (Molding sand)..........	Box 323, Pittsburg...............	Nortonville........
Serra Bros. (Crushed rock -macadam, ballast, rubble, riprap, etc.)..................	R.F.D. Rt. 1, Box 355, Martinez...	Walnut Creek.......
El Dorado County:		
Diamond Springs Lime Co. (Crushed rock -macadam, ballast, rubble, riprap, etc.)....	Diamond Springs..................	Diamond Springs.....

OPERATOR	ADDRESS	LOCATION
Ralph C. Young (Crushed rock - macadam, ballast, rubble, riprap, etc.)............	Rt. 3, Box 252, Placerville......	Placerville........
Fresno County:		
Atchison, Topeka & Santa Fe Railway Co. (Sand and gravel, crushed rock - macadam, ballast, rubble, riprap, etc., decomposed granite........................	121 E. Sixth St., Los Angeles 14..	Oakhurst, Piedra....
Central Rock & Sand Co. (Sand and gravel)..	Sanger..........................	Sanger..............
Herndon Rock Products Co. (Sand and gravel, crushed rock - macadam, ballast, rubble, riprap, etc.)............................	410 Thorne St., P.O. Box 886, Fresno	Herndon............
Pacific Coast Aggregates, Inc. (Sand and gravel, crushed rock - macadam, ballast, rubble, riprap, etc.)..................	400 Alabama St., San Francisco....	Rockfield..........
Sharp & Fellows Construction Co. (Crushed rock - macadam, ballast, rubble, riprap, etc.).................................	533 Central Bldg., Los Angeles 14.	
Thompson Materials & Construction Co., Inc. (Sand and gravel, crushed rock - macadam, ballast, rubble, riprap, etc.)..........	Avenal..........................	Avenal..............
Glenn County:		
E.B. Bishop & Edward Thomas dba Orland Sand & Gravel Co. (Sand and gravel)...........	P.O. Box 469, Orland..............	Orland.............
L.G. Madsen (Sand and gravel)............	246 S. Pluma St., Willows.........	Willows............
Southern Pacific Co. (Sand and gravel)....	65 Market St., San Francisco.......	Wyo................
Humboldt County:		
John Burman & Sons (Sand and gravel).....	2750 Harrison Ave., Eureka.......	Eureka............
Eureka Sand & Gravel Co. (Sand and gravel.)	1920 Williams St., Eureka........	Eureka............

OPERATOR	ADDRESS	LOCATION
Kelly & McWhorter (Sand and gravel)	P. O. Box 572, Fortuna	Fortuna
Mercer Fraser Co., Inc., Essex & Fernbridge (Sand and gravel)	Second and Commercial Sts., Eureak.	Arcata & Fortuna
Northwestern Pacific R.R. Co. (Sand and gravel)	San Rafael	Sequoia
Imperial County:		
Brawley Concrete Co. (Sand and gravel)	P.O. Box 44, Brawley	Brawley
Inland Materials Co. (Sand and gravel)	Box 1024, El Centro	El Centro
Picacho Sand & Gravel Co.(Sand and gravel).	Yuma, Arizona	Winterhaven
Ranco Construction Co. (Sand and gravel)	Box 1328, Brawley	Brawley
Valley Transit Cement Co. (Sand and gravel)	El Centro	El Centro
Yuma Sand and Gravel Co. (Sand and gravel).	1144 W. Eighth St., Yuma, Arizona	Winterhaven
Inyo County:		
Bishop Engineering & Construction Co. (Sand and gravel)	Bishop	Bishop
Dolomite Products Co. (Sand and gravel, crushed rock - macadam, ballast, rubble, rip rap, etc.)	728 E. 29th St., Los Angeles 11	Lone Pine
Mt. Whitney Rock Products, G.L. Watterson (Sand and gravel)	Lone Pine	Lone Pine
Kern County:		
C & H Materials Co. (Sand and gravel)	Box 517, Sta. A, Bakersfield	Bakersfield
Edison Sand Co. (Sand and gravel)	Box 395, Sta. A, Bakersfield	Bakersfield
Griffith Co. (Sand and gravel)	Bakersfield	Bakersfield
Hartman Concrete Materials (Sand and gravel)	P.O. Box 1632, Bakersfield	Bakersfield and Maricopa
Kern Rock Co., Ltd. (Sand and gravel, crushed rock - macadam, ballast, rubble, riprap, etc)	P.O. Box 1697, Bakersfield	Kern River

OPERATOR	ADDRESS	LOCATION
Lake County:		
Aggrelite Co., John C. McFayden (Crushed rock - macadam, ballast, rubble, riprap, etc.)...	1734 Webster St., Oakland.........	
Dariel Camp Rock Co. (Sand and gravel)......	Calistoga........................	Middletown.........
Evans Bros. (Sand and gravel)..............	Kelseyville......................	Kelseyville........
Lange Bros. Sand and Gravel Plant, H. Lange & A. Lange (Sand and gravel).............	Lakeport.........................	Kelseyville........
H.L. McCabe (Sand and gravel)..............	Upper Lake.......................	Upper Lake.........
Lassen County:		
Grayson & Spurgeon (Sand and gravel, crushed rock - macadam, ballast, rubble, riprap, etc.).................................	1512 Fourth St., Susanville.......	Susanville.........
Los Angeles County:		
Arrow Rock Co. (Sand and gravel)...........	11670 Wicks St., Sun Valley.......	Monrovia and Roscoe
A.T. & S.F.R.R., I.L. Hibbard, Gen. Mgr. (Sand and gravel).......................	121 E. Sixth St., Los Angeles 14..	Forbes.............
Azusa Rock & Sand Co. (Sand and gravel)....	P.O. Box 175, Azusa...............	Azusa..............
Richard R. Ball (Sand and gravel, filter sand)	Box 96, Walteria..................	Walteria...........
Blue Diamond Corp., Ltd. (Sand and gravel)..	P.O. Box 2678 Term. Annex Sta., Los Angeles 54......................	El Monte and Roscoe
Wm. J. Bonfield (Decomposed granite).......	2008 Laurel Canyon Rd., Los Angeles	Hollywood..........
Chandler Sand & Gravel, L. Chandler (Sand and gravel)............................	Box 295, Lomita...................	Lomita.............
City Rock Co. (Sand and gravel, crushed rock - macadam, ballast, rubble, riprap, etc.)..	P.O. Box 8, Sunland...............	Sunland............
Connoly-Case-Kiewit Co. (Crushed rock - macadam, ballast, rubble, riprap, etc.)......	2051 Del Amo Blvd., Compton.......	Santa Catalina Island

OPERATOR	ADDRESS	LOCATION
Consolidated Rock Products Co. (Sand and gravel, crushed rock - macadam, ballast, rubble, riprap, etc.)	Box 2950 Terminal Annex or 2730 S. Alameda St., Los Angeles	Los Angeles, Azusa; Roscoe, Monrovia, Baldwin Park and North Hollywood
Gordon Transfer Co. (Sand and gravel)	907 Main St., El Segundo	El Segundo
Graham Bros., Inc. (Sand and gravel)	2000 N. Peck Rd., El Monte	El Monte
Granite Materials Co. (Sand and gravel)	P.O. Box 368, Roscoe	Roscoe
John D. Gregg (Sand and gravel, crushed rock - macadam, ballast, rubble, riprap, etc.)	Box 110, Whittier	Roscoe
Hanawalts (Crushed rock - macadam, ballast, rubble, riprap, etc.)	Box 187, La Verne	Pomona
Lindauer Corp. (Sand and gravel)	Box 337, La Habra	La Habra
Livingston Truck & Materials Co. (Decomposed granite)	3366 Cherry St., Long Beach 7	Rolling Hills
Los Angeles Decomposed Granite Co. (Decomposed granite)	Box 39, Montebello	Montebello
Manning Bros. Rock & Sand Co. (Sand and gravel, crushed rock - macadam, ballast, rubble, riprap, etc.)	P.O. Box C, Irwindale	Irwindale
Wm. R. Magoffin dba Caswell & Co. (Sand and gravel)	2357 E. Slauson Ave., Los Angeles 58	
Mission Rock & Sand Co. (Sand and gravel)	P.O. Box 215, Upland	San Gabriel
Osborn Co. (Sand and gravel)	R.F.D. #1, Box 625, Pasadena	Pasadena
Owl Rock Products Co. (Sand and gravel)	420 S. Alameda St., Compton	Monrovia
Pacific Rock & Gravel Co. (Sand and gravel)	P.O. Box 30, Arrow Highway, Monrovia	Monrovia
Edward Sidebotham & Sons, Inc. (Sand and gravel)	So. End Penn Ave., Lomita	Lomita
Marin County:		
Basalt Rock Co. (Crushed rock - macadam, ballast, rubble, riprap, etc.)	Eighth and River Sts., Napa	McNear Point

OPERATOR	ADDRESS	LOCATION
Hutchinson Co. (Crushed rock -macadam, ballast, rubble, riprap, etc.)	7360 Schmidt Lane, El Cerrito	San Rafael
Marin Gravel Co. (Sand and gravel)	Box 11, Point Reyes Sta	Point Reyes
Mendocino County:		
Ford Gravel Co., Kirby Ford (Sand and gravel)	P.O. Box 74, Ukiah	Ukiah
John Freitas, Ukiah Gravel & Cement Co. (Sand and gravel)	P.O. Box 187, Ukiah	Ukiah
Williams & Baxman (Sand and gravel)	Fort Bragg	Fort Bragg
Merced County:		
Cressy Sand and Gravel Plant, Vernon & Milton Lustre (Sand and gravel)	Rt. 2, Box 360, Merced	Cressey
J.C. Halbert, Merced S. & G. Co. (Sand and gravel)	Rt. 1, Box 219, Winton	Winton
Los Banos Gravel Co. (Sand and gravel)	P.O. Box 1111, Los Banos	Los Banos
River Rock Co. (Sand and gravel)	20 E. 15th St., Merced	Merced
Turlock Rock Co. (Sand and gravel)	P.O. Box 548, Turlock	Ballico
Modoc County:		
Great Northern Railway Co. (Sand and gravel, slag and volcanic cinder)	Klamath Falls, Oregon	Mammoth and Malin
Moyer Gravel Co. (Sand and gravel)	P.O. Box 25, Alturas	Alturas
Monterey County:		
Del Monte Properties Co., C.S. Olmstead (Sand and gravel, crushed rock - macadam, ballast, rubble, riprap, etc.) molding sand)	Del Monte	Pacific Grove
H.W. Kalar (Sand and gravel)	Box 358, Marina	Marina
Metz Aggregate Co. (Sand and gravel)	P.O. Box 900, Watsonville	Watsonville

OPERATOR	ADDRESS	LOCATION
Monterey Sand Co. (Sand and gravel, filter sand)	Box 928, Monterey	Seaside
M.J. Murphy, Inc. (Sand and gravel)	P.O. Box 100, Carmel	Carmel
Pacific Coast Aggregates, Inc. Sand and gravel)	400 Alabama St., San Francisco	Lapis and Prattco
Napa County:		
Basalt Rock Co. (Crushed rock - macadam, ballast, rubble, riprap, etc.)	Eighth and River Sts., Napa	Napa
Benson Gravel Plant (Sand and gravel)	Angwin	Pope Valley
Juarez Quarry, Ted Oliverio (Crushed rock - macadam, ballast, rubble, riprap, etc.).	Napa	Napa
McGill Rock & Sand Co. (Sand and gravel)	602 Florida St., Vallejo	Oakville
Orange County:		
I.P. Arnold (Crushed rock - macadam, ballast, rubble, riprap, etc.)	7655 E. Second St., Downey	Santa Ana
Brace Bros., Inc. (Sand and gravel)	Rt. 1, Box 167, Huntington Beach	Huntington
Geo. T. Calhoun (Sand and gravel)	P.O. Box 1741, Santa Ana	Anaheim
California Rock Co. (Sand and gravel)	R.F.D. Box 46, Orange	Orange
Consolidated Rock Products Co. (Sand and gravel, crushed rock - macadam, ballast, rubble, riprap, etc.)	2730 S. Alameda St., Los Angeles	Fullerton and Orange
Foster Sand & Gravel (Sand and gravel)	915 S. Spadra Rd., Fullerton	Orange
A.E. Fowler & Sons (Sand and gravel)	Rt. 3, 12705 Cambridge St., Orange	Orange
Graham Bros., Inc. (Sand and gravel, crushed rock - macadam, ballast, rubble, riprap, etc.)	2000 N. Peck Rd., El Monte	San Juan Capistrano
D.D. Lawhead & Sons (Sand and gravel, decomposed granite)	Seal Beach	Seal Beach and Buena Park
McClellan & Son (Sand and gravel)	Anaheim	Anaheim

OPERATOR	ADDRESS	LOCATION
Sully-Miller Construction Co. (Sand and gravel, crushed rock -macadam, ballast, rubble, riprap, etc.)	1500 W. Seventh St., Long Beach	El Modena
N. South & Son (Sand and gravel)	Anaheim	Anaheim
Placer County:		
Bear River Sand & Gravel Co. (Sand and gravel)	Colfax	Colfax
Marchell & Miles Gravel Co. (Sand and gravel)	Colfax	Colfax
Union Granite Co., Ruhkala Bros. (crushed rock, -macadam, ballast, rubble, riprap, etc.)	Rocklin	Rocklin
Riverside County:		
A.T. & S.F. Ry. Co. (Crushed rock -macadam, ballast, rubble, riprap, etc.)	121 E. Sixth St., Los Angeles 14	Box Springs
Guy F. Atkinson Co. (Crushed rock, -macadam, ballast, rubble, riprap, etc.)	1103 Heartwell Bldg., Long Beach	Bly Junction
Calavera Materials Co. (Crushed rock -macadam ballast, rubble, riprap, etc.)	P.O. Box 8, Winchester	Winchester
Geo. Herz & Co. (Sand and gravel)	P.O. Box 191, San Bernardino	
Emil Johnson (Crushed rock -macadam, ballast, rubble, riprap, etc.)	Rt. 2, Box 185, Escondido	Perris
Massey Rock & Sand Co. (Sand and gravel)	Box 763, Indio	Indio
Mission Indians (Sand and gravel)	Palm Springs	Palm Springs
Palm Springs Bldrs. Supply Co. (Sand and gravel)	Palm Springs	White Water
San Gorgonio Rock Products (Sand and gravel, crushed rock -macadam, ballast, rubble, riprap, etc.)	1990 N. Hargrove St., Banning	Banning
Service Rock Co., (Sand and gravel)	Box 309, Riverside	Riverside
Transit Mixed Concrete Co. (Sand and gravel)	3464 E. Foothill Blvd., Pasadena	Corona

OPERATOR	ADDRESS	LOCATION
Valley Rock & Sand Corp. (Sand and gravel).	Rt. 1, Box 198, San Jacinto	Moreno
Sacramento County:		
American River Sand & Gravel Co. (Sand and gravel)	P.O. Box 156, Perkins	Perkins
Brighton Sand and Gravel Co. (Sand and gravel)	P.O. Box 2604, Sacramento 10	Perkins
Cannon & Co. (Molding sand)	Box 802, Sacramento	North Sacramento
Del Paso Rock Products Co. (Sand and gravel)	3490 Fair Oaks Blvd., Sacramento	Del Paso
Fair Oaks Gravel Co. (Sand and gravel)	Rt. 1, Box 533, Illinois Ave., Fair Oaks 19	Fair Oaks
McGillivray Construction Co. (Sand and gravel)	P.O. Box 873, Sacramento	Sacramento
Pacific Coast Aggregates, Inc. (Sand and gravel, crushed rock -macadam, ballast, rubble, riprap, etc.)	400 Alabama St., San Francisco	Fair Oaks, Prattrock and American River
Perkins Gravel Co. (Sand and gravel)	1846-37th St., Sacramento	Perkins
M.R. Powell & Co. (Sand and gravel)	Box 815, Sacramento	American River
J.R. Reeves (Sand and gravel, crushed rock -macadam, ballast, rubble, riprap, etc.).	P.O. Box 1072, Sacramento	Sacramento
San Benito County:		
Granite Rock Co. (Crushed rock -macadam, ballast, rubble, riprap, etc.)	Box 151, Watsonville	Logan
Buzz Young Sunnyslope Building Supply (Sand and gravel)	Rt. 1, Box 50, Hollister	Hollister
San Bernardino County:		
A.T. & S.F. Ry. Co. (Crushed rock -macadam, ballast, rubble, riprap, etc.)	121 E. Sixth St., Los Angeles	Newberry

OPERATOR	ADDRESS	LOCATION
Consolidated Rock Products Co. (Sand and gravel, crushed rock -macadam, ballast, rubble, riprap, etc.)	2730 S. Alameda St., Los Angeles	Claremont
Fontana Gravel Co. (Sand and gravel)	Fontana	Fontana
Fourth St. Rock Crusher (Sand and gravel)	P.O. Box 469, San Bernardino	San Bernardino
Hanawalt Bros., Sand and Gravel (Sand and gravel)	Box 187, La Verne	Pomona
Geo. Herz & Co. (Sand and gravel)	P.O. Box 191, San Bernardino	San Bernardino
Holiday Rock Co. (Sand and gravel)	P.O. Box 215, Upland	Upland and Colton
Redlands Gravel Co. (Sand and gravel)	305 S. Buena Vista St., Redlands	Redlands
San Bernardino Rock & Gravel Co. (Sand and gravel)	1910 W. Seventh St., San Bernardino	San Bernardino
Triangle Rock & Gravel Co. (Sand and gravel, crushed rock, -macadam, ballast, rubble, riprap, etc.)	San Bernardino	San Bernardino
Union Pacific Railroad Co. (Sand and gravel)	2025 Hunter St., Los Angeles	Baxter
San Diego County:		
Charles & Victor Arnell, Lakeside Sand Plant (Sand and gravel)	Rt. 1, Box 10, Lakeside	Lakeside
Canyon Rock Co. (Sand and gravel, crushed rock (macadam, ballast, rubble, riprap, etc.)	Box F, Hillcrest Sta., San Diego	San Diego
Caudell & Johnson (Sand and gravel)	Box B, Hillcrest Sta., San Diego	Mission Valley, Poway Valley
Crystal Silica Co. (Sand and gravel, filter sand)	717 E. 61st St., Los Angeles	Oceanside
Daley Corp. (Sand and gravel)	Mission Valley & Ward Rd., San Diego	San Diego
Denton's Sand Plant, Edmond Denton (Sand and gravel)	4166 Pepper Dr., San Diego	El Cajon

OPERATOR	ADDRESS	LOCATION
H.G. Fenton Material Co., Inc. (Sand and gravel)	1245 National Ave., San Diego	San Diego
Howard & Haskins (Sand and gravel)	P.O. Box 81, Santee	Santee
Hubbard Molding Sand Co. (Molding sand)	2700 Barnson Pl., San Diego	San Diego
Mica Gem Mining & Milling Co. (Sand and gravel)	Jacumba	Jacumba
Nelson & Sloan (Sand and gravel)	Box 488, Chula Vista	Chula Vista
Earl E.Smith Sand Plant (Sand and gravel)	Rt. 2, Box 253, Lakeside	Lakeside
Carl Niemann (Sand and gravel)	Box 52, Del Mar	Del Mar
D.M. Sebastian (Crushed rock - macadam, ballast, rubble, riprap, etc.)	4330 Fairmont Ave., San Diego	San Diego
Vista Cement Products, A.J. McFall (Sand and gravel)	P.O. Box 182, Vista	Vista
Woodward Sand Co., Arthur C. Woodward (Sand and gravel)	Rt. 2, Box 190M, Mission Valley Rd., San Diego	San Diego
San Joaquin County:		
Frank P. Brendel & Spencer S. Decker (Sand and gravel)	1705 Oxford St., Berkeley	Stockton
Frank B. Marks & Sons (Sand and gravel)	P.O. Box 668, Newman	Tracy
Pacific Coast Aggregates, Inc. (Sand and gravel, crushed rock - macadam, ballast, rubble, riprap, etc.)	400 Alabama St., San Francisco	Riverbank, Tracy, Kerlinger
Pereira Bros. (Sand and gravel)	P.O. Box 770, Tracy	Tracy
Putnam Sand & Gravel Co. (Sand and gravel)	P.O. Box 486, Modesto	Riverbank
Sante Fe Sand and Gravel Co. (Sand and gravel)	Box 385, Escalon	Escalon
P.F. Sievers, Mokelumne Pit (Sand and gravel)	P.O. Box 24, Clements	Clements
Tracy Rock & Gravel Co. (Sand and gravel)	2101 Weber St., Stockton	Tracy
E.J. Warner (Sand and gravel)	1103 Sycamore, Stockton 39	Stockton
Clyde Wood Co. (Sand and gravel)	P.O. Box 599, Lodi	Clements

OPERATOR	ADDRESS	LOCATION
San Luis Obispo County:		
Guiton Molding Sand Co. (Sand and gravel, molding sand)	Oceano	Oceano
Walter B. Roselip (Sand and gravel)	Box 251, San Luis Obispo	Atascadero
San Mateo County:		
A.& B. Quarry (Crushed rock - macadam, ballast, rubble, riprap, etc.)	P.O. Box 1037, Redwood City	Woodside
Brisbane Rock Co. (Crushed rock - macadam, ballast, rubble, riprap, etc.)	P.O. Box 638, Brisbane	Brisbane
Brumely-Donaldson Co. (molding sand)	557 Howard St., San Francisco	South San Francisco
H. Morton (Crushed rock - macadam, ballast, rubble, riprap, etc.)	Box 192, Menlo Park	Redwood City
San Mateo Feed & Fuel Co. (Crushed rock, -macadam, ballast, rubble, riprap, etc.)	850 San Mateo Dr., San Mateo	Belmont
Rockaway Quarry, Inc. (Sand and gravel, crushed rock - macadam, ballast, rubble, riprap, etc.)	340 Pine St., San Francisco	Rockaway Beach
Ken Royce, Inc. (Crushed rock - macadam, ballast, rubble, riprap, etc.)	185 Bayshore Blvd., San Francisco	Rockaway Beach
Shoreland Co. (Crushed rock - macadam, ballast, rubble, riprap, etc.)	Pescadero	Pescadero
Peter Sorenson (Crushed rock - macadam, ballast, rubble, riprap, etc.)	927 Arguello, Redwood City	Belmont
Santa Barbara County:		
H.G. Iliff & Son (Sand and gravel)	Box 373, Santa Maria	Santa Maria
Henry G. Petersen, dba Buell Flat Rock Co. (Sand and gravel)	Solvang	Solvang
Southern Pacific Milling Co. (Sand and gravel)	735 State St., Santa Barbara	Santa Maria

OPERATOR	ADDRESS	LOCATION
Santa Clara County:		
Los Gatos Aggregate Materials, Johnson & Rinehart (Sand and gravel)	138 E. Main St., Los Gatos	Los Gatos
Los Gatos Sand and Gravel Co. (Sand and gravel)	P.O. Box 507, Los Gatos	Los Gatos
George Neary (Crushed rock -macadam, ballast, rubble, riprap, etc.)	Rt. 1, Box 604, Los Altos	Los Altos
Pacific Coast Aggregates, Inc. (Sand and gravel, crushed rock -macadam, ballast, rubble, riprap, etc.)	400 Alabama St., San Francisco	Coyote and Campbell, San Jose
Permanente Cement Co. (Crushed rock -macadam, ballast, rubble, riprap, etc.)	Permanente	Permanente
A.J. Raisch Paving Co. (Sand and gravel)	900 W. San Carlos St., San Jose	San Jose
Rhodes & Robinson, Stanford Quarry (Crushed rock -macadam, ballast, rubble, riprap, etc.)	Box 325, Palo Alto	Palo Alto
Western Gravel Corp. (Sand and gravel)	P.O. Box 855, Campbell	Campbell
Western Tile & Supply Co. (Sand and gravel)	Gilroy	Gilroy
Santa Cruz County:		
Henry J. Kaiser Co. (Sand and gravel)	1924 Broadway, Oakland	Olympia
Pacific Coast Aggregates, Inc. (Sand and gravel, crushed rock -macadam, ballast, rubble, riprap, etc.)	400 Alabama St., San Francisco	Olympia
Santa Cruz Aggregate Co. (Sand and gravel)	P.O. Box 485, Felton	Felton and Olympia
Santa Cruz Portland Cement Co. (Crushed rock -macadam, ballast, rubble, riprap, etc.)	Crocker Bldg., San Francisco	Davenport
Shasta County:		
J.H. Hein Co. (Sand and gravel)	Redding	Redding

OPERATOR	ADDRESS	LOCATION
Oaks Sand, Gravel & Cement Products Co., (Sand and gravel, crushed rock -macadam, ballast, rubble, riprap, etc.)	1737 Yuba St., Redding	Redding
Siskiyou County:		
John S. Jensen & M.N. Thompson (Sand and gravel)	Mount Shasta	Mount Shasta
Southern Pacific R.R. Co., Chief Engineer (Slag and volcanic cinder)	Southern Pacific Bldg., San Francisco	Kegg
A. Young (Sand and gravel)	Yreka	Yreka
Solano County:		
Harms Bros. (Sand and gravel)	5261 Stockton Blvd., Sacramento	Vacaville
Roy & Joe Manos (Sand and gravel)	P.O. Box 455, Winters	Winters
J.M. Nelson, Cordelia Quarry (Crushed rock, -macadam, rubble, ballast, riprap, etc).	Cordelia	Cordelia
Parish Bros. (Crushed rock -macadam, ballast, rubble, riprap, etc.)	Benicia	Benicia
Sonoma County:		
Basalt Rock Co. (Sand and gravel, crushed rock -macadam, ballast, rubble, riprap, etc.)	Eighth and River Sts., Napa	Healdsburg
Thomas A. Graham (Crushed rock - macadam, ballast, rubble, riprap, etc.)	Box 1, Occidental	Occidental
Hein Bros. Basalt Rock Co., Mark Hein, Pres., (Crushed rock - macadam, ballast, rubble, riprap, etc.)	Petaluma	Petaluma
Mirabel Gravel Co., S. Cangros (Sand and gravel)	San Rafael	Mirabel

OPERATOR	ADDRESS	LOCATION
Stony Point Quarry, W.A. Wilson (Crushed rock - macadam, ballast, riprap, rubble, etc.)	Petaluma Star Route	Stony Point
Taylor Gravel Co., Harvey Taylor (Sand and gravel)	Healdsburg	Healdsburg
Stanislaus County:		
Hubert H. Everest, Sr., (Sand and gravel).	P.O. Box 100, Westley	
Johnson Bros. (Sand and gravel)	Rt. 1, Box 1880, Modesto	Modesto
Frank B. Marks & Sons (Sand and gravel)	P.O. Box 668, Newman	Newman
Modesto Sand and Gravel Co., (Sand and gravel)	Rt. 2, Box 901 R, Modesto	Modesto
Putnam Sand & Gravel Co. (Sand and gravel)	P.O. Box 486, Modesto	Modesto
J.C. Scanlon, Scanlon Gravel Pit (Sand and gravel)	Patterson	Newman
C. Skove & J. Wychopen (Sand and gravel)	Rt. 1, Box 28, Turlock	Tuolumne River
Wallace Material Co. (Sand and gravel)	P.O. Box 246, Escalon	Escalon
Chas. D. Warner & Son, Inc. (Sand and gravel)	1027 Waterford Rd., Modesto	Modesto
Tehama County:		
Allen & Ready (Sand and gravel)	Box 726, Red Bluff	Red Bluff
Baker Trucking Co., (Sand and gravel, crushed rock - macadam, ballast, rubble, riprap, etc.)	Hamilton City	Hamilton City
Draper & Adams (Sand and gravel)	315 Walnut St., Red Bluff	Red Bluff
Liston Ehorn (Sand and gravel)	Box 328, Red Bluff	Red Bluff
Wm. G. Taber (Sand and gravel)	Red Bluff	Red Bluff
Trinity County:		
Northwestern Pacific R.R. Co. (Crushed rock - macadam, ballast, rubble, riprap, etc.).	San Rafael	Island Mountain

OPERATOR	ADDRESS	LOCATION
Tulare County:		
O.C. Jeffers (Sand and gravel)	1032 River Rd., Porterville	Porterville
Middletons (Sand and gravel)	Visalia	Porterville
Pacific Coast Aggregates, Inc. (Sand and gravel, crushed rock - macadam, ballast, rubble, riprap, etc.,)	400 Alabama St., San Francisco	Lindsay
Sequoia Rock Co. (Sand and gravel)	P.O. Box 133, Lemoncove	Lemoncove
Terminus Beach Rock Co. (Sand and gravel)	P.O. Box 291, Lemoncove	Lemoncove
Tuolumne County:		
Beerman & Jones (Sand and gravel, crushed rock - macadam, ballast, rubble, riprap, etc.)	Sonora	Lemoncove
Ventura County:		
Montalvo Rock Co. (Sand and gravel)	Box 188, Montalvo	Montalvo
Santa Paula Rock Co. (Sand and gravel)	P.O. Box 671, Santa Paula	Santa Paula
Saticoy Rock Co. (Sand and gravel, crushed rock - macadam, ballast, rubble, riprap, etc.)	Box 970, Ventura	Saticoy-Ventura
Ventura Molding Sand Co., O.D. Messmore, (Molding sand)	P.O. Box 1808, Ventura	Ventura
Yolo County:		
Godin Gravel, Frank Godin (Sand and gravel)	Woodland	Woodland
Roy G. Manos (Sand and gravel)	Box 455, Winters	Winters
Leroy Kerr (Sand and gravel)	Box 34, Yolo	Yolo
Schwarzgruber & Sons (Sand and gravel, crushed rock - macadam, ballast, rubble, riprap, etc. etc.)	28 W. Maine St., Woodland	Woodland
J. Dudley Stephens (Sand and gravel)	Box 79, Woodland	Esparto

OPERATOR	ADDRESS	LOCATION
Yuba County:		
Hallwood Sand & Gravel Co. (Sand and gravel)	711 Wilkie Way, Yuba City	Marysville
Rice Bros. (Sand and gravel)	P.O. Box 1446, Modesto	Marysville
Yuba River Sand Co. (Sand and gravel)	Marysville	Marysville
SANDSTONE		QUARRY
Los Angeles County:		
Blue Goose Quarry, Robert Cox (Sandstone flagstone for building)	1975 Lundy Ave., Pasadena	Pasadena
Monterey County:		
Carmel Stone Quarry, A.L. Possadori (Carmelstone for building)	Box 185, Carmel	Carmel
Napa County:		
H.F. Galbreath (Sandstone flagstone for building)	1659 Oakview Ave., Berkeley	Monticello
Santa Barbara County:		
C. Antalini (Sandstone flagstone for building)	131 E. Gutierrez St., Santa Barbara	Tajiguas
SERPENTINE		QUARRY
Santa Clara County:		
The Permanente Metals Corp. (name changed to Kaiser Aluminum & Chemical Corp. on November 28, 1949)	Permanente	Almaden

OPERATOR	ADDRESS	LOCATION
SILICA		MINE
Mariposa County:		
The Permanente Metals Corp. (name changed to Kaiser Aluminum & Chemical Corp, on November 28, 1949) (Quartz)	Permanente	Le Grande
Monterey County:		
Del Monte Properties (Glass sand)	Del Monte	Pacific Grove
Owens-Illinois Glass Co. (Glass sand)	P.O. Box 359, Pacific Grove	Pacific Grove
Riverside County:		
Owens-Illinois Glass Co. (Glass sand)	P.O. Box 298, Corona	Corona
San Bernardino County:		
Mineral Materials Co., C.W. Dunton, Mgr., (Quartzite)	1145 Westminster Ave., Alhambra	Oro Grande
Temescal Clay Co. (Quartzite)	2569 Clarendon Ave., Huntington Park	Victorville
SLATE		QUARRY
El Dorado County:		
Pacific Minerals Co., Ltd., (Granules, crude)	337 10th St., Richmond	Chili Bar
Inyo County:		
Blue Star Mines, Ltd. (Filler)	810 S. Spring St., Los Angeles	Bigpine
Huntley Industrial Minerals Inc., (Granules, filler)	Bishop	
James F. Nikalous (Granules)	109 S. Main St., Bigpine	Bigpine
Tuolumne County:		
Sonora Marble Aggregates Corp. (Granules, crude, filler)	Box 653, Sonora	Sonora

OPERATOR	ADDRESS	LOCATION
SODA		PLANT
Inyo County:		
Natural Soda Products Co. (Soda ash, Trona)	506 Central Tower Bldg., San Francisco 3	Keeler
The Permanente Metals Corp. (name changed to Kaiser Aluminum & Chemical Corp. on November 28, 1949) (Soda ash)	Kaiser Bldg., Oakland 12	Lone Pine
Pittsburg Plate Glass Co., Columbia Chemical Division (Soda ash, Trona)	Bartlett	Bartlett
San Bernardino County:		
American Potash & Chemical Co. (Soda ash, Salt cake)	3030 W. Sixth St., Los Angeles 54	Trona
Dale Chemical Industries, Inc. (Salt cake)	P.O. Box 319, Twenty-nine Palms	Twenty-nine Palms
West End Chemical Co. (Soda ash)	608 Latham Sq. Bldg., Oakland 12.	Westend
SULFUR		MINE
Inyo County:		
Crater Group, R.E. Kitching	P.O. Box 783, Bigpine	Bigpine
TALC, PYROPHYLLITE, AND SOAPSTONE		MINE
El Dorado County:		
Pacific Minerals Co., Ltd.. (Soapstone)	337 10th St., Richmond	Shingle Springs
Inyo County:		
W.H. Andersen (Talc)	517 N. Ave. 50, Los Angeles 42	Eureka Valley
William Bonham (Talc)	Lone Pine	Keeler
Louise Grantham (Talc)	809 E. Sixth St., Ontario	Shoshone
F.M. Henderson (Talc)	Box 24, Moapa, Nevada	Bigpine
Huntley Industrial Minerals Inc. (Talc)	P.O. Box 305, Bishop	Talc City
T.O. Imus (Pyrophyllite)	Bigpine	Bigpine

OPERATOR	ADDRESS	LOCATION
George W. Koest (Talc)	Darwin	Darwin
Little & Hildebrand (Talc)	P.O. Box 15, Bigpine	Bigpine
Monte Little & Ray Horlis (Talc)	Bigpine	Bigpine
James F. Nikolaus (Talc)	109 S. Main St., Bigpine	Bigpine
Sierra Talc & Clay Co. (Talc)	5509 Randolph St., Los Angeles 22	Keeler, Tecopa, and Shoshone
H.N. Stewart & Homer Taylor (Talc)	Bigpine	Lone Pine
Los Angeles County:		
Dr. Leon Katz (Soapstone)	3239 Weldon Ave., Los Angeles 41	Acton
Mono County:		
Charles Bowen (Pyrophyllite)	Laws	Laws
Huntley Industrial Minerals, Inc. (Pyrophyllite)	P.O. Box 305, Bishop	Laws
San Bernardino County:		
Desert Talc & Clay Co. (Talc)	Pomona	Yucca Grove
Minerals Material Co. (Pyrophyllite)	1145 Westminister Ave., Alhambra	Victorville
Sierra Talc and Clay Co. (Talc)	5509 Randolph St., Los Angeles 22	Baker and Shoshone.
Southern California Minerals Co., W.S. Skeoch (Talc)	320 S. Mission Rd., Los Angeles	Yucca Grove and Shoshone
Western Talc Co. (Talc)	1901 E. Slauson Ave., Los Angeles.	Tecopa
San Diego County:		
Pioneer Pyrophyllite Products(Pyrophyllite)	Box 686, Chula Vista	Cardiff

METALLICS

MINE	OPERATOR	ADDRESS	LOCATION
CHROMITE			MINE
Butte County:			
Lambert..........	R.F. Helmke..................	320 Market St., San Francisco..	Magalia.......
Del Norte County:			
High Plateau......	Eugene Brown..................	O'Brien, Ore..................	Crescent City.
Tyson (French Hill)	Sam J. Wilson................	Patricks Creek Tavern via Crescent City....................	Crescent City.
Tehama County:			
Tedoc & Red Mountain	Harry Moore..................	Platina.......................	Platina.......
COPPER (Principal copper producers in California in 1949 - not less than 10,000 pounds)			MINE
Calaveras County:			
Penn.............	Penn Chemical Company.........	Campo Seco, California........	Campo Seco....
Inyo County:			
Darwin Mines......	Anaconda Copper Mining Co.....	25 Broadway, New York, N.Y....	Darwin........
Pine Creek........	U.S. Vanadium Corp...........	30 E. 42nd St., New York......	Bishop........
Shoshone Mines....	Anaconda Copper Mining Co.....	25 Broadway, New York, N.Y....	Tecopa........
San Bernardino County:			
New Trail.........	New Trail Mining Co., & Alloy Mining Co...................	2320 N. Alameda St., Compton, California..................	Nipton........
Mohawk...........	Mohawk Mines, Inc............	Nipton, California...........	Nipton........
Roosevelt-Bagdad Chase..........	Donald F. Love...............	Box D, Ludlow, California.....	Ludlow........

MINE	OPERATOR	ADDRESS	LOCATION
Shasta County:			
Afterthought......	Coronado Copper & Zinc Co.....	1206 Pacific Mutual Bldg., Los Angeles, California..........	Ingot........
Hornet...........	Mountain Copper Co., Ltd......	216 Pine St., San Francisco, California..................	Matheson.....
GOLD (Principal gold producers in California out of a total of 432 placer operators and lode mines in 1949 - not less than 100 ounces)			MINE
Amador County:			
Arroyo Seco Ranch (dragline).....	Lee Stock.....................	Ione, California.............	Ione.........
Belden (lode gold mine)..........	Belden Amador Mines, Inc......	Box 28, Fort Wayne, Ind.......	Pine Grove...
Kennedy Tailings (tailings dump)	Frank J. Fuller...............	Jackson, California..........	Jackson......
Kreth Ranch (hydraulic mine)......	Kreth Mines...................	Ione, California.............	Ione.........
Lilly Dredge (dragline)..........	Ernest L. Lilly...............	1640 E. Poplar St., Stockton, California..................	Plymouth.....
Old Eureka (lode gold mine).....	Central Eureka Mining Co......	2505 Russ Bldg., San Francisco 4, California..................	Sutter Creek.
Butte County:			
Butte Unit (dredge-bucket-line)...	Yuba Consolidated Goldfields..	351 California St., San Francisco California..................	Oroville.....
Kister Dredge dredge - bucket-line).........	Gold Hill Dredging Co.........	311 California St., San Francisco, California...........	Oroville.....

MINE	OPERATOR	ADDRESS	LOCATION
Lancha Plana Dredge No. 5 (dredge - bucket-line)...	Lancha Plana Gold Dredging Co...	La Lomita Rancho, Lockeford, California......................	Chico.........
Calaveras County:			
Blackstone (lode gold mine).....	Blackstone Mine...............	907 Pierce St., Albany, California......................	West Point.....
Penn (zinc mine)..	Penn Chemical Co...............	Campo Seco, California.........	Campo Seco.....
Royal (lode gold mine)..........	Frank Tower, Joe Paltor et al..	Copperopolis, California.......	Copperopolis...
El Dorado County:			
Cosumnes (lode gold mine)..........	Cosumnes Mines, Inc...........	Grizzly Flats, California......	Grizzly Flats...
David (dragline)..	Lord and Bishop................	Box 812, Sacramento, California	Greenwood......
Hazel Creek (lode gold mine).....	Hazel Creek Mine..............	Box 302, Pollock Pines, California......................	Pollack Pines..
Keables (dragline).	Lord and Bishop...............	Box 812, Sacramento, California	Clarksville via Folsom.........
River Pine Dredge (dragline)......	River Pine Mining Co., Ltd.....	141 Battery St., San Francisco, California..................	Diamond Springs
Shaw (lode gold mine)..........	Volo Mining Co................	464 Main St., Placerville, California......................	Placerville....
Twin Forks Dredge (dragline)......	Twin Forks Dredging Co.........	1831 P St., Sacramento, California.........................	Youngs.........
Fresno County:			
Rockfield Plant (dryland dredge, commercial gravel plant)	Pacific Coast Aggregates, Inc...	400 Alabama St., San Francisco, California..................	Friant.........

MINE	OPERATOR	ADDRESS	LOCATION
Inyo County:			
Darwin Mines (zinc-lead mine)......	Anaconda Copper Mining Co.......	25 Broadway, New York, N.Y.....	Darwin........
Shoshone Mines (lead mine).....	Anaconda Copper Mining Co.......	25 Broadway, New York, N.Y.....	Tecopa........
Kern County:			
C & H Materials Co., (dryland dredge, commercial gravel plant)..........	C & H Materials Co.............	Box 517, Sta. A. Bakersfield, California..................	Bakersfield...
Cactus Queen (gold-silver mine)....	Burton Bros....................	Rosamond, California..........	Rosamond......
Hidden Treasure (lode gold mine)	Basin Mining Co................	Box 726, Bakersfield, California	Bodfish.......
Standard (lode gold mine)...........	Earl Blickenstaff, et al........	Rosamond, California..........	Mojave........
Tropico (Tropico Kid, Trailer Wheel Shafts) (lode gold mine)	Burton Bros., et al............	Rosamond, California..........	Rosamond......
Madera County:			
Heiskell property (suction dredge)	Robt. Brock, G.H. Griffin and Ernest Noble..................	Box 23, River Rte., Madera, California......................	Raymond.......
Howell Bros. (suction dredge)....	Howell Bros....................	Box 73, Raymond, California....	Raymond.......
Wishon and Watson (suction dredge)	Williams and Santoni...........	Rte. 1, Box 591C, Fresno, California......................	Friant........

MINE	OPERATOR	ADDRESS	LOCATION
Mariposa County:			
Bear Creek (dragline)	James H. Henry	706 California Bldg., Stockton, California	Mariposa
Diltz-Oro Grande (lode gold mine)	Diltz Oro Grande Mines Co.	414-21st St., Merced, California	Mariposa
Mount Gaines (lode gold mine)	Mount Gaines Mining Co.	Hornitos, California	Hornitos
Specimen (lode gold mine)	Eli J. Maria	Bear Valley, California	Bear Valley
Thurman & Wright Dredge No. 3 (dragline)	Thurman and Wright	235 Montgomery St., San Francisco, California	Hornitos
Merced County:			
A. & G. (dragline)	A. & G. Co.	Box 890, Modesto	Le Grand
Merced Dredge No. 1 (dredge - bucket-line)	Merced Dredging Co.	1805 Mills Tower, San Francisco 4, California	La Grange
Snelling Dredges (dredge - bucket-line)	Snelling Gold Dredging Co.	Snelling, California	Snelling
Nevada County:			
Ancho & Erie Groups (lode gold mine)	Ancho Erie Mining Co.	401 Second St., San Francisco 7, California	Washington
Eastman (dryland dredge)	Crescent Pacific Mining Co.	260 California St., San Francisco, California	North Columbia.
Empire Star Group (lode gold mine)	Empire Star Mines Co., Ltd.	Box 1027, Grass Valley, California	Grass Valley
Idaho & Brunswick Units (lode gold mine)	Idaho Maryland Mines Corp.	362 Russ Bldg., San Francisco, California	Grass Valley

MINE	OPERATOR	ADDRESS	LOCATION
Omega (hydraulic mine)..........	Goldfield Cons. Mines Co........	1 Montgomery St., San Francisco, California..................	Washington...
Relief Hill (hydraulic mine).......	A.P. Landsburg & Joe Swazey	Star Rte., Graniteville, California.........................	North Bloomfield
Southern Mill (terminal cleanup)..	Emma Southern..................	152 Empire St., Grass Valley, California...................	Grass Valley..
Stockton Hill (lode gold mine)......	Stockton Hill Mine.............	Box 577, Menlo Park, California	Wolf..........
Waukashau (hydraulic mine)..........	Geo. F., Ned J., and Frank Mellott	Star Rte., Graniteville, California.........................	North Bloomfield
Placer County:			
Mary Len (lode gold mine)..........	Mary Len Mine..................	Newcastle, California.........	Newcastle.....
Virginia Town (dryland dredge)....	Virginia Town Gold Mine and Schwartz & Mitchell...........	1177 Pacific Ave., San Francisco and 7771 Twin Oaks Ave., Roseville, California............	Lincoln.......
Plumas County:			
Lucky Bend-First Chance (dragline)	R. & M. Mining Co..............	Strawberry Valley, California..	Strawberry Valley..........
Sacramento County:			
Capital Dredges (dredge -bucket-line)..........	Capital Dredging Co............	351 California St., San Francisco,	Fair Oaks.....
Cosumnes Dredge (dredge - bucket-line)..........	Cosumnes Gold Dredging Co.......	475 California St., San Francisco,	Sloughhouse...
Fair Oaks Gravel Plant (dryland dredge, commercial gravel plant)...	Fair Oaks Gravel Co............	Rte. 1 Box 533, Fair Oaks, Calif.	Fair Oaks.....

MINE	OPERATOR	ADDRESS	LOCATION
General Dredge (dragline)......	General Dredging Co............	Natoma, California............	Natoma........
Lancha Plana Dredge No. 4 (dredge - bucket-line)...	Lancha Plana Gold Dredging Co...	La Lomita Rancho, Lockeford, California......................	Folsom........
Natomas Dredges (dredge - bucket-line)..........	Natomas Company................	Box 1197, Sacramento, California	Natoma........
Van Vleck (dragline)	Mountain Gold Dredging Co.......	Sutter Creek, California.......	Michigan Bar...
San Bernardino County:			
Pioneer Group (lode gold mine).....	Baird, Martin, Ralson & Ralson	Box 103, Johannesburg, California	Johannesburg...
Roosevelt-Bagdad Chase (lode gold mine).........,	Donald F. Love..................	Box D. Ludlow, California......	Ludlow.........
Spud Patch (dryland dredge tungsten mine).........	Surcease Mining Co.............	214-30th St., Sacramento 14, California......................	Red Mountain...
Super Mold (dryland dredge).......	Surcease Mining Co.............	214-30th St., Sacramento 14, California......................	Red Mountain...
San Joaquin County:			
Lower Comanche Dredge (dredge - bucket-line)..........	Gold Hill Dredging Co..........	311 California St., San Francisco	Camanche ......
Upper Comanche Dredge (dredge - bucket-line)....	Gold Hill Dredging Co........ .	311 California St., San Francisco	Camanche......

MINE	OPERATOR	ADDRESS	LOCATION
Shasta County:			
Afterthought (zinc mine).........	Coronado Copper & Zinc Co.......	1206 Pac. Mutual Bldg., Los Angeles, California	Ingot.........
MacDonald (dragline)	Roy S. Olson...................	1178 Walnut Ave., Redding, California......................	Redding.......
Thurman Gold Dredge (dredge - bucket-line)..........	Thurman Gold Dredging Co........	960 Russ Bldg., San Francisco 4, California..................	Redding.......
Yankee John (lode gold mine)......	Shasta Mining Associates and Igo Mining Co.....................	486 California St., San Francisco and Redding, California.......	Redding.......
Sierra County:			
Alaska (lode gold mine)..........	H.L. Sorenson	685-6th St., San Francisco 1, California....................	Pike..........
Brush Creek (lode gold mine)......	Brush Creek Mine...............	Goodyear Bar, California........	Goodyear Bar...
Kate Hardy (lode gold mine)......	John O'Donnell.................	Forest via Alleghany, California	Alleghany......
Original Sixteen to One(lode gold mine)..........	Original Sixteen to One Mine, Inc.	1611 Russ Bldg., San Francisco 4, California....................	Alleghany......
Siskiyou County:			
Indian Creek Placer (dredge - bucket-line)..........	French Gulch Dredging Co........	940 Russ Bldg., San Francisco 4, California..................	Fort Jones.....
Reeves Ranch (dredge bucket-line)....	Reeves Ranch Dredging Co.,	Box 7, Happy Camp, California..	Happy Camp.....
Siskiyou Unit(dredge bucket-line)....	Yuba Consolidated Gold Fields....	351 California St., San Francisco 4, California................	Callahan.......
Star (dragline)....	Emmor W. Little................	Box 584, Yreka, California.....	Yreka.........

MINE	OPERATOR	ADDRESS	LOCATION
Stanislaus County:			
La Grange Dredge No. 4 (dredge - bucket-line)....	La Grange Gold Dredging Co.....	1805 Mills Tower, San Francisco, California..................	La Grange....
Tuolumne Gold Dredge (dredge - bucket-line)..........	Tuolumne Gold Dredging Co......	1 Montgomery St., San Francisco 4, California................	La Grange....
Trinity County:			
Fairview Placers (dredge - bucket-line)..........	Fairview Placers..............	Lewiston, California..........	Lewiston.....
Mires & Underseth Dredge (dredge - bucket-line)....	Mires & Garner................	Trinity Center, California.....	Trinity Center
Red Hill (Barthol-Jacobs) (hydraulic mine).......	Goldfield Cons. Mines Co.......	1 Montgomery St., San Francisco, California..................	Junction City.
Swanson (hydraulic mine)..........	Swanson Mining Co.............	Salyer, California............	Salyer........
Tuolumne County:			
Ford (pocket mine)	Ralph W., & Jo M. Tapley.......	Columbia, California..........	Columbia......
Yuba County:			
Blue Point (hydraulic mine)........	Rosebar Development Co.........	Box 413, Smartville, California	Smartville....
Dannebroge (lode gold mine)..........	Empire Star Mines Co., and lessees	Box 1027, Grass Valley, Calif..	Browns Valley
Nevada (dragline).	W.I. Lanham....................	Camptonville, California.......	Camptonville..
Willow Creek & Oak Valley (dragline)	J.E. Clark.....................	Camptonville, California.......	Camptonville..

MINE	OPERATOR	ADDRESS	LOCATION
Yuba Unit (dredge - bucket-line)....	Yuba Consolidated Gold Fields...	351 California St., San Francisco 4, California.................	Hammonton.....
IRON			MINE
Riverside County:			
Eagle Mountain....	Kaiser Co., Inc................	P.O. Box 217, Fontana..........	Desert Center.
San Bernardino County:			
Bessemer..........	Bessemer Mines Inc., James Utt...	514½ N. Main, Santa Ana.........	Newberry......
Cave Canyon.......	Mineral Materials Co...........	1145 Westminster Ave., Alhambra.	Baker.........
Vulcan............	Kaiser Co., Inc................	P.O. Box 217, Fontana..........	Kelso.........
LEAD			MINE
Calaveras County:			
Penn..............	Penn Chemical Co...............	Campo Seco, California.........	Campo Seco....
Inyo County:			
Colorado Group....	R.J. Wright and Thomas Taylor...	Panamint Springs via Lone Pine, California....................	Panamint Springs via Lone Pine
Darwin Mines......	Anaconda Copper Mining Co.......	25 Broadway, New York, N.Y......	Darwin........
Defense...........	Foreman and Skinner............	1354-2nd Ave., Salt Lake City, Utah	Panamint Springs via Lone Pine
Empress...........	Joe McCulley...................	Box 53, Darwin, California......	Darwin........
Gold Bottom.......	A.I. Mills.....................	Box 238, Marfa, Texas..........	Trona.........
Nancy Hanks.......	W. Denman and E. Carlson........	Big Pine, California...........	Bigpine ......
Keystone..........	H.C. Goyn and W.D. Goyn.........	Darwin, California.............	Darwin........
Lippincott........	Geo. Lippincott................	Box 1811, Santa Ana, California.	Scotty's Castle
Minnietta.........	Ross Finley and Tom Vignich.....	c/o Panamint Springs Resort via Lone Pine, California.........	Panamint Springs via Lone Pine
Ophir (dump)......	Damon and Damon................	1612 Oregon St., Redding, Calif.	Redding.......
Queen of Sheba and Carbonate.......	New Sutherland Divide Mining Co.	6757 Hollywood Blvd., Hollywood, California....................	Shoshone......
Red Cloud.........	Harry E. Briggs................	Box 613, Trona, California......	Trona.........
Reward (Brown Monster)..........	Dick & T.L. Bright and Dr. Walter Wilson.......................	Independence and Bishop, California..........................	Independence..

MINE	OPERATOR	ADDRESS	LOCATION
Santa Rosa.......	Santa Rosa Mining Co............	Keeler, California............	Keeler........
Shoshone Mines...	Anaconda Copper Mining Co.......	25 Broadway, New York, N.Y.....	Tecopa........
Silver Spoon.....	Frank & Weslyn Wiese, J.A. Hoppe and Bert Quinn................	Boxes 6 and 71, Darwin, California...........................	Darwin........
Surprise.........	A.L. Foss and J. Osborne........	Lone Pine, California.........	Panamint Springs via Lone Pine.
Ubehebe..........	Ubehebe Mines, Inc..............	356 So. Spring St., Los Angeles, California..................	Beatty, Nevada.
Riverside County:			
Black Eagle......	Eagle Lead Co..................	Indio, California..............	Indio........
San Bernardino County:			
Carbonate King Zinc	J.Q. Little & Crystal Cave Mining Co...........................	Clark Mt. Station, Nipton, Calif.	Nipton........
Little Mike (Blue Bell)..........	R.V. Waughtel.................	Baker, California..............	Baker.........
Mohawk...........	Mohawk Mines, Inc..............	Nipton, California.............	Nipton........
Wilshire (Mohawk).	Altana Corp....................	Nipton, California.............	Nipton........
Shasta County:			
Afterthought......	Coronado Copper & Zinc Co.......	1206 Pacific Mutual Bldg., Los Angeles, California..........	Ingot.........
MANGANESE			MINE
Plumas County:			
Brato............	Utah Construction Co...........	1 Montgomery St., San Francisco.	Crescent Mills
San Bernardino County:			
Owl Holes.........	Howard W. Orwig................	1079½ Leighton Ave., Los Angeles	Owl Springs....

MINE	OPERATOR	ADDRESS	LOCATION
MERCURY (QUICKSILVER) (Excluding names of a few small mines for which no data were available other than those obtained from purchasers)			MINE
Fresno County:			
Archer...........	Archer Mining Co., Inc.........	510 S. Spring St., Los Angeles	Coalinga.......
Napa County:			
Oat Hill..........	William Maker.................	Box 240 Middletown............	Pope Valley....
San Benito County:			
Aurora............	R. Diaz.......................	Idria.........................	Idria..........
Juniper...........	Berg & Sciochetti.............	P.O. Box 637, Hollister........	Panoche........
New Idria.........	New Idria Quicksilver Mining Co.	Mills Bldg., San Francisco......	Idria..........
North Star........	Leonard W. Knepper............	P.O. Box 98, Idria..............	Idria..........
San Luis Obispo County:			
La Libertad........	Moapa Mining Co................	Box 325, Paso Robles...........	Cambria........
Santa Clara County:			
Guadalupe.........	P. de Michelis.................	142 Oxford St., San Francisco...	Los Gatos......
New Almaden Dump...	Almaden Dumps..................	Almaden.......................	Almaden........
Sonoma County:			
Mt. Jackson........	Sonoma Quicksilver Mines, Inc...	58 Sutter St., San Francisco....	Guerneville....
MOLYBDENUM			MINE
Inyo County:			
	U.S. Vanadium Corp.............	30 E. 42nd St., New York 17, N.Y.	Bishop.........

MINE	OPERATOR	ADDRESS	LOCATION
PLATINUM GROUP METALS			DEPOSIT
Butte County:			
	Gold Hill Dredging Co.	311 California St., San Francisco	Oroville
Mariposa County:			
	Thurman & Wright	960 Russ Bldg., San Francisco	Hornitos
Merced County:			
	Merced Dredging Co.	1805 Mills Tower, San Francisco	La Grange
	Snelling Gold Dredging Co.	Snelling	Snelling
Sacramento County:			
	Capital Gold Dredging Co.	351 California St., San Francisco	Fair Oaks
	General Dredging Co.	Natoma	Natoma
	Thurman & Wright	960 Russ Bldg., San Francisco	Sloughhouse
San Joaquin County:			
	Gold Hill Dredging Co.	311 California St., San Francisco	Camanche
Shasta County:			
	Thurman Gold Dredging Co.	960 Russ Bldg., San Francisco	Redding
Siskiyou County:			
	Reeves Ranch Dredging Co.	Happy Camp	Happy Camp
	Yreka Gold Dredging Co.	220 Montgomery St., San Francisco	Seiad Valley
Yuba County:			
	Yuba Consolidated Gold Fields	351 California St., San Francisco	Hammonton
QUICKSILVER--see MERCURY			

MINE	OPERATOR	ADDRESS	LOCATION
SILVER (Principal silver producers in California in 1949 - not less than 1,000 ounces)			MINE
Amador County:			
Old Eureka (lode gold mine)	Central Eureka Mining Co.	2505 Russ Bldg., San Francisco 4, California	Sutter Creek
Butte County:			
Butte Unit (dredge - bucket-line)	Yuba Consolidated Goldfields	351 California St., San Francisco, California	Oroville
Calaveras County:			
Penn (zinc mine)	Penn Chemical Co.	Campo Seco, California	Campo Seco
Inyo County:			
Darwin Mines (zinc-lead mine)	Anaconda Copper Mining Co.	25 Broadway, New York, N.Y.	Darwin
Defense (lead mine)	Foreman and Skinner	1354-2nd Ave., Salt Lake City, Utah	Panamint Springs via Lone Pine
Keystone (lead mine)	H.D. Goyn and W.D. Goyn	Darwin, California	Darwin
Lippincott (zinc-lead mine)	Geo. Lippincott	Box 1811, Santa Ana, California	Scotty's Castle
Minnietta (lead mine)	Ross Finley & Tom Vignich	c/o Panamint Springs Resort, Lone Pine, California	Panamint Springs via Lone Pine
Pine Creek (tungsten mine)	U.S. Vanadium Corp.	30 E. 42nd St., New York, N.Y.	Bishop
Queen of Sheba and Carbonate (lead mine)	New Sutherland Divide Mining Co.	6757 Hollywood Blvd., Hollywood, California	Shoshone
Reward (Brown Monster) (lead mine)	Dick Bright, T.L. Bright, and Dr. Walter Wilson	Independence and Bishop, California	Independence
Santa Rosa (lead mine)	Santa Rosa Mining Co.	Keeler, California	Keeler

MINE	OPERATOR	ADDRESS	LOCATION
Shoshone Mines (lead mine)...........	Anaconda Copper Mining Co.......	25 Broadway, New York, N.Y.....	Tecopa.........
Surprise (lead mine)	A.L. Ross and J. Osborne........	Lone Pine, California..........	Panamint Springs via Lone Pine.
Kern County:			
Cactus Queen (gold-silver mine)....	Burton Bros......................	Rosamond, California...........	Rosamond.......
Standard (lode gold mine)...........	Earl Blickenstaff et al.........	Rosamond, California...........	Mojave.........
Tropico (Tropico, Kid, Trailer, Wheel Shafts) (lode gold mine)...........	Burton Bros, et al..............	Rosamond, California...........	Rosamond.......
Nevada County:			
Empire Star Group (lode gold mine)	Empire Star Mines Co., Ltd.......	Box 1027, Grass Valley, California	Grass Valley....
Idaho & Brunswick Units (lode gold mine)...........	Idaho Maryland Mines Corp.......	362 Russ Bldg., San Francisco, California...................	Grass Valley....
Placer County:			
Mary Len (lode gold mine)..........	Mary Len Mine.................	Newcastle, California..........	Newcastle.....
San Bernardino County:			
Carbonate King Zinc (zinc mine).....	J.Q. Little & Crystal Cave Mining Co...........................	Clark Mt. Station, Nipton, California.......................	Nipton........

MINE	OPERATOR	ADDRESS	LOCATION
La Platita - Annex-Silver Hill (silver mine)	California Silver Corp.	5177 Overland Ave., Culver City, California	Baker
Mohawk (lead mine)	Mohawk Mines, Inc.	Nipton, California	Nipton
Roosevelt-Bagdad Chase (lode gold mine)	Donald F. Love	Box D, Ludlow, California	Ludlow
Wilshire (Mohawk) (lead mine)	Altana Corp.	Nipton, California	Nipton
Shasta County:			
Afterthought (zinc mine)	Coronado Copper & Zinc Co.	1206 Pacific Mutual Bldg., Los Angeles, California	Ingot
Hornet (pyrite mine)	Mountain Copper Co., Ltd.	216 Pine St., San Francisco, California	Matheson
Sierra County:			
Original Sixteen to One (lode gold mine)	Original Sixteen-to-One mine, Inc.	1611 Russ Bldg., San Francisco, California	Alleghany
Yuba County:			
Yuba Unit (dredge - bucket-line)	Yuba Consolidated Gold Fields	351 California St., San Francisco 4, California	Hammonton
TITANIUM			MINE
Los Angeles County:			
	Ferro-Titan Minerals Co., N.C. Amen & F.M. Moody	212 Bank of America Bldg., Glendale	Sun Valley

MINE	OPERATOR	ADDRESS	LOCATION
TUNGSTEN			MINE
Alpine County:			
Alpine	Alpine Mining Co.	P.O. Box 114, Gardnerville, Nev.	Markleeville
Fresno County:			
Garnet Dike	Sheridan & Bennett	Fresno	Kings River
Inyo County:			
Brownstone	El Diablo Mining Co.	Box 567, Bishop	Bishop
Pine Creek	U.S. Vanadium Corp.	30 E. 42nd St., New York, N.Y.	Bishop
Round Valley	O.A. Kittle Mining & Exploration Co.	Box 478, Bishop	Bishop
Yaney	Adams & Van Voorhis	Bishop	Bishop
Kern County:			
Tungsten Chief	W.C. Thompson	20728 Ventura Blvd., Woodland Hills	Caliente
Madera County:			
Strawberry	Fresno Mining Co.	415 Brix Bldg., Fresno	Bass Lake
Mono County:			
Black Rock	Tungstar Corp.	Rt. 2, Bishop	Benton
San Bernardino County:			
Spud Patch Placers and Atolia	Surcease Mining Co.	P.O. Box 786, Sacramento	Atolia
Tulare County:			
Big Jim	Tulare County Tungsten Mines	Box 361, Lindsay	Lindsay
Harrel Hill	Consolidated Tungsten	Box 366, Dinuba	Orosi
Sherman Peak	Sherman Peak Mining Co.	Kernville	Kernville

MINE	OPERATOR	ADDRESS	LOCATION
ZINC (Principal zinc producers in California in 1949 - not less than 10,000 pounds)			MINE
Calaveras County:			
Penn	Penn Chemical Co.	Campo Seco, California	Campo Seco
Inyo County:			
Darwin Mines	Anaconda Copper Mining Co.	25 Broadway, New York, N.Y.	Darwin
Ophir (dump)	Damon and Damon	1612 Oregon St., Redding, Calif.	Trona
Red Cloud	Harry E. Briggs	Box 613, Trona, California	Trona
Shoshone Mines	Anaconda Copper Mining Co.	25 Broadway, New York, N.Y.	Tecopa
Silver Spoon	Frank & Weslyn Wiece, J.A. Hoppe & Bert Quinn	Boxes 6 and 71, Darwin, Calif.	Darwin
San Bernardino County:			
Carbonate King Zinc	J.Q. Little & Crystal Cave Mining Co.	Clark Mt. Station, Nipton, Calif.	Nipton
Shasta County:			
Afterthought	Coronado Copper & Zinc Co.	1206 Pacific Mutual Bldg., Los Angeles, California	Ingot

DIRECTORY OF MINERAL DEALERS AND COMMERCIAL LABORATORIES

LIST OF MINERAL DEALERS, CUSTOM MILLS, AND COMMERCIAL GRINDING PLANTS IN CALIFORNIA

FIRM	REMARKS
American Minerals Co., 840 Mission Rd., Los Angeles, Calif.	Commercial grinding of minerals.
Atkins, Kroll & Co. 320 California St. San Francisco 4, Calif.	Dealer in tungsten ores, mercury, gypsum and limerock.
Baroid Sales Division National Lead Co., 830 Ducommun St., Los Angeles, Calif.	Talc and other soft non-metallic minerals ground by contract or purchased.
Bishop Concentrate & Cleaning Co. Bishop, Calif.	Custom mill; purchases tungsten ores and base metal ores.
Blood, Harry E., Co., 5028 Alhambra Ave., Los Angeles, Calif.	Dealer in industrial sand and silica products.
Blue Star Mines, Ltd., 667 S. Anderson, Los Angeles, Calif. (Mill at Zurich)	Dealer in talc and clay.
Bradley & Ekstrom, 320 Market St., San Francisco 11, Calif.	Dealers in all commercial minerals.
Brumley-Donaldson Co., 557 Howard St., San Francisco 5, Calif., and 3050 E. Slauson Ave., Huntington Park, Calif.	Dealer in sand, clay, limestone, dolomite, and other minerals.
Burton Bros., Rosamond, Kern County, Calif.	Custom cyanide mill. Gold and silver ores purchased.
Butte Lode Mining Co., Randsburg, Calif.	Custom amalgamation mill, gold-silver ore.

Commercial Minerals Co., 310 Irwin St., San Francisco 7, Calif.	Commercial grinding by contract or minerals purchased.
Dailey Chemical Laboratories, Box 228, Oroville, Calif.	Custom mill for black sands.
Empire Star Mines Co., Ltd., Grass Valley, Calif.	Amalgamation, flotation and cyanide mill; gold ore and concentrates purchased.
Hidecker Co., 800 S. Mission Rd., Los Angeles, Calif.	Clay grinding plant; non-metallic minerals ground by contract or purchased.
Hill Bros. Chemical Co., 2159 Bay St., Los Angeles, Calif.	Grinding asbestos, and custom milling of small lots of soft non-metallic minerals.
Holmestake Mining Co., P O. Box 308, Winterhaven, Calif.	Cyanide mill; gold and silver ores purchased.
Huntley Industrial Minerals, P.O. Box 305, Bishop, Calif.	Dealers in talc, pyrophyllite, garnet sands, clay and mica.
Industrial Minerals & Chemical Co., 836 Gilman St., Berkeley, Calif.	Non-metallic minerals ground by contract or purchased.
Kennedy Minerals Co., 2550 E. Olympic Blvd., Los Angeles, Calif.	Non-metallic minerals ground by contract or purchased.
Los Angeles Chemical Co., 1960 S. Santa Fe Ave., Los Angeles, Calif.	Dealer in non-metallic minerals.
Mojave Mining & Milling Co. Martin Beck, Mojave, Calif.	Custom mill, amalgamation and flotation
Ontario Rock Milling Co., 7557 E. Olive, Paramount, Calif.	Non-metallic minerals ground by contract or purchased. Roofing granules prepared.

Sierra Talc & Clay Co., 5509 Randolph St., Los Angeles 22, Calif.	Dealers in talc and clays.
Southern California Minerals Co., 320 S. Mission Rd, Los Angeles, Calif.	Dealer in talc, clay and other minerals.
Twining Laboratories, 2527 Fresno St., Fresno, Calif.	Purchase and concentrate tungsten ores on a custom basis, also commercial grinding.
U.S. Vanadium Co. Bishop	Tungsten mill, ore purchased.
Western Talc Co., 1901 E. Slauson Ave., Los Angeles, Calif.	Non-metallic mineral grinding plant; minerals ground by contract or purchased.

LIST OF SMELTERS AND MINERAL DEALERS REPORTING PURCHASE OF CALIFORNIA METALS PRODUCED IN 1949

Name	Address	Location of plant	Metals reported purchased
American Smelting & Ref. Co.	120 Broadway, New York, N.Y.	Amarillo, Texas	Zinc
American Smelting & Ref. Co.	120 Broadway, New York, N.Y.	El Paso, Texas	Copper, gold, silver
American Smelting & Ref. Co.	120 Broadway, New York, N.Y.	Garfield, Utah	Copper, lead, gold, silver
American Smelting & Ref. Co.	120 Broadway, New York, N.Y.	Hayden, Arizona	Copper, gold, silver
American Smelting & Ref. Co.	120 Broadway, New York, N.Y.	Murray, Utah	Lead, copper, gold, silver
American Smelting & Ref. Co.	405 Montgomery St., San Francisco	Selby, California	Copper, lead, gold, silver
American Smelting & Ref. Co.	120 Broadway, New York, N.Y.	Tacoma, Washington	Copper, lead, gold, silver
Anaconda Copper Mining Co.	25 Broadway, New York 4, N.Y.	Anaconda, Montana	Copper, lead, zinc, gold, silver
Anaconda Copper Mining Co.	25 Broadway, New York 4, N.Y.	Great Falls, Mont.	Zinc
Bethlehem Pacific Coast Steel Corporation	20th and Illinois Sts., San Francisco	San Francisco	Iron ore
Bradley & Ekstrom	320 Market St., San Francisco	San Francisco	Manganese, chromite, iron ore
Bradley Mining Co.	Crocker Bldg., San Francisco	Stibnite, Idaho	Antimony
Braun Corporation	2260 E. 15th St., Los Angeles	Los Angeles	Quicksilver
Coast Chemical Division F.W. Berk & Co., Inc.	Sharon Bldg., San Francisco	San Francisco	Quicksilver
International Smelting & Ref. Co.	Kearns Bldg., Salt Lake City, Utah	Miami, Arizona	Copper, gold, silver
International Smelting & Ref. Co.	Kearns Bldg., Salt Lake City, Utah	Tooele, Utah	Copper, lead, zinc, gold, silver
Kaiser Co., Inc.	P.O. Box 217, Fontana	Fontana	Iron ore, manganese ore, chromite
Kennecott Copper Corp.	120 Broadway, New York, N.Y.	McGill, Nevada	Copper, gold, silver
Mefford Chemical Co.	1026 Santa Fe, Los Angeles	Los Angeles	Quicksilver

Pacific Vegetable Oil Co., Bernard T. Rocca	62 Townsend St., San Francisco	San Francisco	Quicksilver
Quicksilver Producers Ass'n., Irving Ballard, Sec'y.	407 Sansome St., San Francisco	San Francisco	Quicksilver
Sullivan Mining Co.	Wallace, Idaho	Silver King, Idaho	Zinc
Twining Laboratories	2527 Fresno St., Fresno	Fresno	Tungsten ore
U.S. Mint	Duboce & Market Sts., San Francisco	San Francisco	Gold, silver
U.S. Smelting, Refining & Mining Co.	Newhouse Bldg., Salt Lake City, Utah	Midvale, Utah	Copper, lead, zinc, gold, silver
Western Gold & Platinum Works	589 Bryant St., San Francisco	San Francisco	Platinum, gold, silver*
Wildberg Bros. Smelting & Ref. Co.	742 Market St., San Francisco	San Francisco	Platinum, gold, silver*

*Gold and silver in special high-grade ores only.

LIST OF COMMERCIAL ASSAY AND TESTING LABORATORIES

SAN FRANCISCO AREA

FIRM	REMARKS
Ball, C.M., 911 University Ave., Berkeley 2, Calif.	Fire assay, chemical analysis of ores and minerals.
Curtis & Thomkins, 236 Front St., San Francisco 11, Calif.	Chemical analysis of ceramic materials, chemical analysis of ores and minerals.
Hall Laboratories, Inc., 200 Davis St., San Francisco 11, Calif.	Chemical analysis of ores and minerals, water analysis.
Hamilton, Beauchamp & Woodworth 564 Market St., San Francisco 4, Calif.	Ore dressing, beneficiation.
Hanks, Abbott A., Inc., 624 Sacramento St., San Francisco 11, Calif.	Fire assay, chemical analysis of ceramic materials, chemical analysis of ores and minerals, ore dressing, beneficiation, petrographic analysis, physical tests, spectrographic analysis, water analysis.
Hersey Inspection Bureau (engineers, chemists, and testers of building materials, foundations.) 3405 Piedmont Ave., Oakland, Calif.	
Hunt, Robert W., Co., 251 Kearny St., San Francisco 8, Calif.	Fire assay, chemical analysis of ceramic materials, chemical analysis of ores and minerals, physical tests.
Metallurgical Laboratories, 604 Mission St., San Francisco 5, Calif.	Chemical analysis of ceramic materials, chemical analysis of ores and minerals, spectrographic analysis, water analysis.

Multiphase, Inc., 351 Eighth St., San Francisco 3, Calif.	Fire assay, chemical analysis of ores and minerals, spectrographic analysis.
Pacific Chemical Laboratories, 617 Montgomery St., San Francisco 11, Calif.	Chemical analysis of ceramic materials, chemical analysis of ores and minerals, petrographic analysis, spectrographic analysis, water analysis.
Pittsburg Testing Laboratories, 651 Howard St., San Francisco 5, Calif.	Fire assay, chemical analysis of ceramic materials, chemical analysis of ores and minerals, ore dressing, beneficiation, petrographic analysis, physical tests, spectrographic analysis, water analysis.
Western Gold and Platinum Works, 589 Bryant St., San Francisco 7, Calif.	Fire assay, chemical analysis of ores and minerals, ore dressing beneficiation.
Western Machinery Co. 760 Folsom St., San Francisco 3, Calif.	Ore dressing, beneficiation.
Wildberg Bros., 742 Market St., San Francisco 2, Calif.	Fire assay.

LOS ANGELES AREA

California Testing Laboratories, Inc., 619 E. Washington Los Angeles 15, Calif.	Fire assay, chemical analysis of ceramic materials, chemical analysis of ores and minerals, ore dressing, physical tests.
Dorr Co., 811 W. 7th St., Los Angeles 14, Calif.	Ore dressing, beneficiation.
Eisenhauer, Ed., Jr., 322 S. San Pedro St., Los Angeles, Calif.	Fire assay, chemical analysis of ores and minerals.
Fess, Edward E., 5905 Pacific Blvd., Huntington Park, Calif.	Ore dressing, beneficiation.
Gooch, Geo. W., Laboratories, 2580 E. 8th St., Los Angeles, Calif.	Fire assay, chemical analysis of ores and minerals.

Herman, John 920 Santee St., Los Angeles 15, Calif.	Fire assay, spectrographic analysis.
Herr, A.V., 5176 Hollywood Blvd., Los Angeles, Calif.	Fire assay, chemical analysis of ores and minerals.
Hollywood Testing Laboratories, 1257 N. La Brea Ave., Hollywood 38, Calif.	Fire assay, chemical analysis of ceramic materials, chemical analysis of ores and minerals, ore dressing, beneficiation, petrographic analysis, physical tests, spectrographic analysis, water analysis, x-ray diffraction.
Hunt, Robert W., Co. 6353 Miles Ave., Huntington Park, Calif.	Chemical analysis of ores and minerals.
Kennard & Drake, 4686 S. Sante Fe Ave., Los Angeles 11, Calif.	Chemical analysis of ceramic materials, chemical analysis of ores and minerals, ore dressing, beneficiation physical tests, spectrographic analysis.
Lewis & Walker, 111 W. 11th St., Los Angeles, Calif.	Fire assay, chemical analysis of ores and minerals.
Los Angeles Testing Laboratory, 1300 S. Los Angeles St., Los Angeles 15, Calif.	Fire assay, chemical analysis of ceramic materials, chemical analysis of ores and minerals, ore dressing, beneficiation, physical tests, spectrographic analysis.
Meco Assayers, 417 S. Hill St., Los Angeles, Calif.	Fire assay, chemical analysis of ores and minerals.
Metal Control Laboratories, 1220 Maple Ave., Los Angeles 15, Calif.	Chemical analysis of ores and minerals, physical tests, spectrographic analysis.
Minerals Engineering 417 S. Hill St., Los Angeles 13, Calif.	Fire assay, chemical analysis of ceramic materials, chemical analysis of ores and minerals.
The National Supply Co., 1524 Border Ave., Torrance, Calif.	Chemical analysis of ores and minerals, ore dressing, beneficiation, physical tests.
Osborne, Raymond G., Laboratories 110 W. Ninth St., Los Angeles 15, Calif.	Fire assay, chemical analysis of ceramic materials, chemical analysis of ores and minerals, physical tests.

Pacific Platinum Works, 253 S. Broadway Los Angeles, Calif.	Fire assay.
Sill, Harley A., 1011 S. Figueroa St., Los Angeles 15, Calif.	Fire assay, chemical analysis of ceramic materials, chemical analysis of ores and minerals, petrographic analysis.
Smith-Emery Co., 920 Santee St., Los Angeles 15, Calif.	Fire assay, chemical analysis of ceramic materials, chemical analysis of ores and minerals, ore dressing, beneficiation, petrographic analysis, spectrographic analysis.
Southwestern Engineering Co., 4800 S. Santa Fe Ave., Los Angeles, Calif.	Ore dressing, beneficiation.
Truesdail Laboratories, Inc., 4101 N. Figueroa Los Angeles, Calif.	Chemical analysis of ores and minerals.
Triplett & Barton, Inc., 826 N. Victory Blvd., Burbank, Calif.	Chemical analysis of ores and minerals, spectrographic analysis (rare earth analyses)
von Huene, Rudolph (thin and polished sections), 865 N. Mentor Ave., Pasadena, Calif.	
Ward, S. Paul, Inc. (ceramic testing) 605 Mission St., South Pasadena, Calif.	

Other Areas

Brooks Laboratories, 2300 National Ave., National City, Calif.	Chemical analysis of ores and minerals.
Clarkson Chemical Laboratories, 1548 6th Ave., San Diego, Calif.	Fire assay, chemical analysis of ores and minerals.
Coast Laboratory 1859 S. Van Ness Ave., Fresno, Calif.	Chemical analysis of ores and minerals.

Daily Chemical Laboratory Box 228, Oroville, Calif.	Black sand assay.
Hornkohl Laboratories, 716 Truxton Ave., Box 1673, Bakersfield, Calif.	Fire assay, chemical analysis of ores and minerals.
Morse Laboratories, 316 16th St., Sacramento, Calif.	Fire assay, chemical analysis of ceramic materials, chemical analysis of ores and minerals, ore dressing, beneficiation, physical tests.
Nevada City Assay & Refining Office Ott, E.J.N., 130 Main St., Nevada City, Calif.	Fire assay, chemical analysis of ores and minerals, milling tests.
Rombaugh, M.D., 3069 Del Paso Blvd., North Sacramento, Calif.	Fire assay, chemical analysis of ores and minerals
San Diego Testing Laboratories, Administration Bldg., Baldwin Park, San Diego, Calif.	Fire assay, chemical analysis of ores and minerals, ore dressing, physical tests.
San Joaquin Research Laboratory, 8 W. Weber St., Box 1987, Stockton, Calif.	Fire assay, chemical analysis of ores and minerals.
Scheave, Harold, 237 Commercial St., Nevada City, Calif.	Fire assay, chemical analysis of ores and minerals.
Twining Laboratories, 2527 Fresno St., Box 1472 Fresno, Calif.	Fire assays, chemical analysis of ceramic materials, chemical analysis of ores and minerals, ore dressing, petrographic analysis, physical tests, spectrographic analysis, water analysis, x-ray diffraction.

DIVISION OF MINES
OLAF P. JENKINS, CHIEF

STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES

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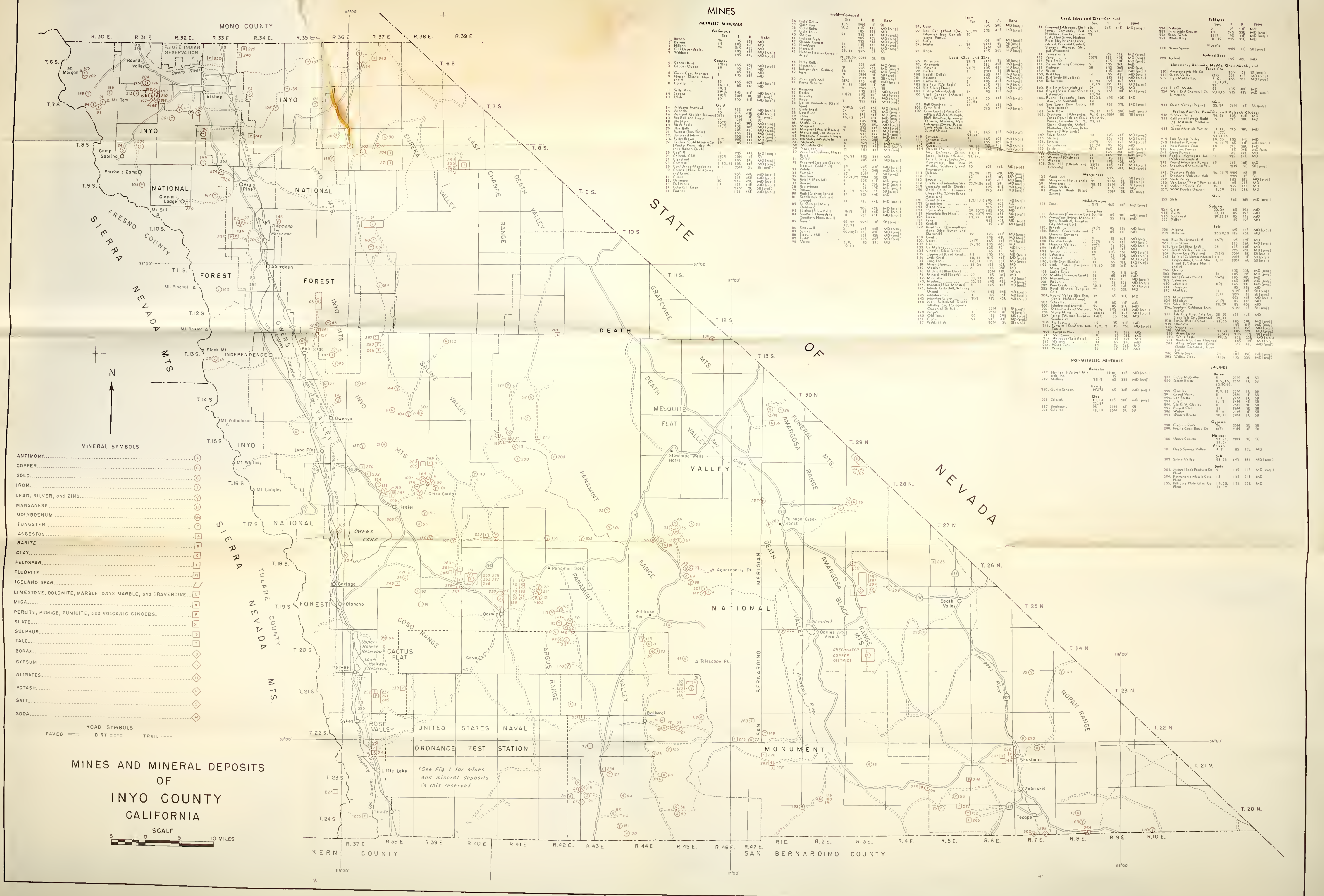
MINES
METALLIC MINERALS
NONMETALLIC MINERALS
SALINES
MONO COUNTY
PAIUTE INDIAN RESERVATION
Bishop
Big Pine
Independence
Lone Pine
Keeler
Olancha
Darwin
Shoshone
Tecopa
Death Valley
Stovepipe Wells Hotel
Furnace Creek Ranch
OWENS LAKE
INYO NATIONAL FOREST
SIERRA NEVADA MTS.
FRESNO COUNTY
TULARE COUNTY
KERN COUNTY
SAN BERNARDINO COUNTY
STATE OF NEVADA
DEATH VALLEY NATIONAL MONUMENT
PANAMINT RANGE
ARGUS RANGE
COSO RANGE
INYO MTS.
GRAPEVINE MTS.
FUNERAL MTS.
AMARGOSA RANGE
BLACK MTS.
NOPAH RANGE
SALINE VALLEY
PANAMINT VALLEY
OWENS VALLEY
ROSE VALLEY
MESQUITE FLAT
CACTUS FLAT
UNITED STATES NAVAL ORDNANCE TEST STATION
(See Fig. 1 for mines and mineral deposits in this reserve)
MINERAL SYMBOLS
ANTIMONY
COPPER
GOLD
IRON
LEAD, SILVER, and ZINC
MANGANESE
MOLYBDENUM
TUNGSTEN
ASBESTOS
BARITE
CLAY
FELDSPAR
FLUORITE
ICELAND SPAR
LIMESTONE, DOLOMITE, MARBLE, ONYX MARBLE, and TRAVERTINE
MICA
PERLITE, PUMICE, PUMICITE, and VOLCANIC CINDERS
SLATE
SULPHUR
TALC
BORAX
GYPSUM
NITRATES
POTASH
SALT
SODA
ROAD SYMBOLS
PAVED
DIRT
TRAIL
N
SCALE
5 0 5 10 MILES

MINES AND MINERAL DEPOSITS OF INYO COUNTY CALIFORNIA

STATE OF CALIFORNIA
EARL WARREN, Governor
DEPARTMENT OF NATURAL RESOURCES
WARREN T. HANNUM, Director

DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO 11
OLAF P. JENKINS, Chief

Vol. 47 JULY 1951 No. 3

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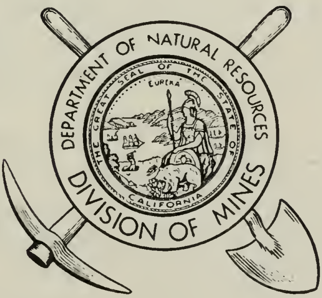


STATE OF CALIFORNIA
EARL WARREN, Governor
DEPARTMENT OF NATURAL RESOURCES
WARREN T. HANNUM, Director

DIVISION OF MINES
OLAF P. JENKINS, Chief

Headquarters
Third Floor, Ferry Building, San Francisco 11

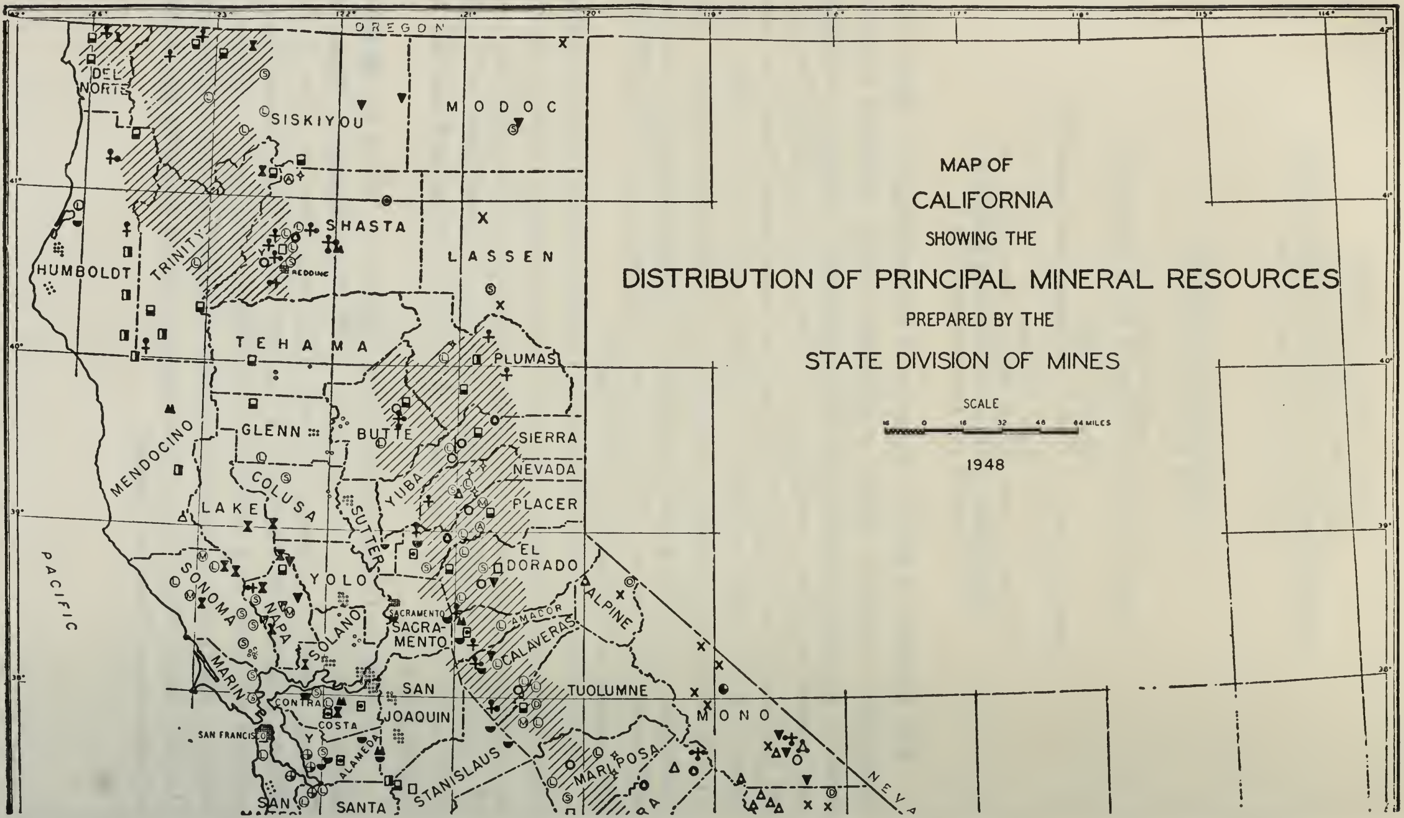
Branch Office
State Building, 217 West First Street, Los Angeles 12

District Offices
3rd Floor, State Office Bldg. 1, Sacramento 14
Department of Natural Resources Building
Cypress and Lanning, Redding

The Division of Mines maintains at its headquarters offices in San Francisco a technical library containing several thousand books and scientific journals on geology, mining, mineralogy, chemistry, metallurgy, and related subjects; a reading room containing periodicals devoted to the petroleum and mining industries, and newspapers from the mining centers of the state; exhibits of minerals, rocks, mine models, etc.; a service laboratory for the determination of California minerals; and a conference room with a mining engineer in attendance to serve the public and to sell publications of the Division. Publications are also sold at the Los Angeles and Sacramento district offices.

In addition to oral conferences in the offices of the Division of Mines, information concerning the mineral resources, mineral industry, geology, and mining operations of California is distributed to the public by means of publications, monthly releases, and letters. Each letter of inquiry received by the Division is answered by the technical staff member best qualified to do so.

The principal publications of the Division of Mines are **Bulletins**, **Special Reports**, and the quarterly **California Journal of Mines and Geology**, issued in January, April, July, and October of each year. **Mineral Information Service** is a monthly news release concerning the mineral resources and industry of California, designed to inform the public of discoveries, operations, markets, statistics, and new publications. It is distributed without cost upon request. A list of available publications will also be sent free upon request.

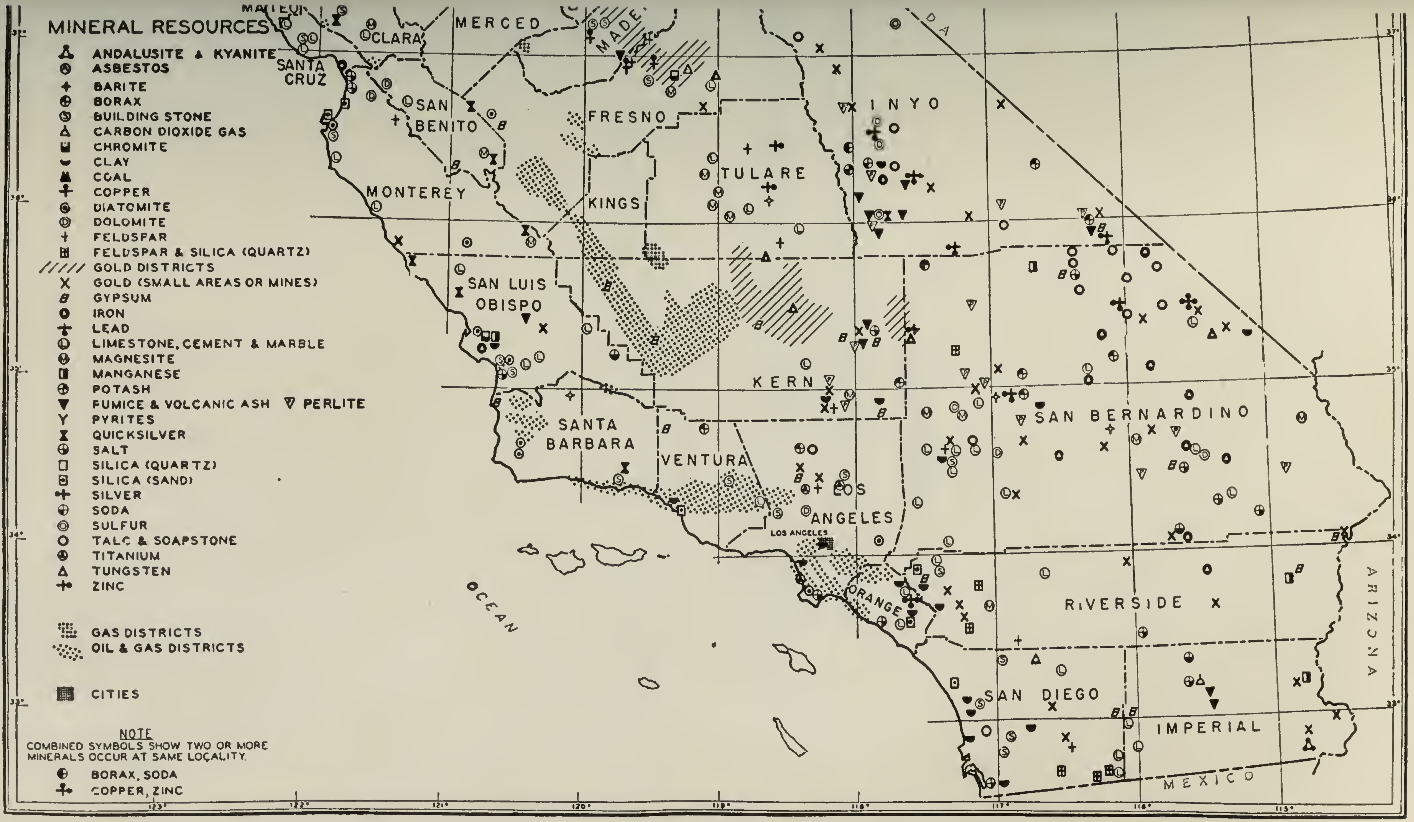


MAP OF
CALIFORNIA
SHOWING THE
DISTRIBUTION OF PRINCIPAL MINERAL RESOURCES
PREPARED BY THE
STATE DIVISION OF MINES

SCALE

1948

16 0 16 32 48 64 MILES
OREGON
NEVA
PACIFIC
DEL NORTE
SISKIYOU
MODOC
HUMBOLDT
TRINITY
SHASTA
REDDING
LASSEN
TEHAMA
PLUMAS
GLENN
BUTTE
SIERRA
NEVADA
MENDOCINO
COLUSA
YUBA
PLACER
LAKE
SUTTER
EL DORADO
SONOMA
NAPA
YOLO
ALPINE
SACRAMENTO
SACRA-MENTO
AMADOR
SOLANO
CALAVERAS
MARIN
TUOLUMNE
CONTRA COSTA
SAN JOAQUIN
MONO
SAN FRANCISCO
ALAMEDA
STANISLAUS
MARIPOSA
SAN MATEO
SANTA
124° 123° 122° 121° 120° 119° 118° 117° 116° 115° 114°
42° 41° 40° 39° 38°


MINERAL RESOURCES
ANDALUSITE & KYANITE
ASBESTOS
BARITE
BORAX
BUILDING STONE
CARBON DIOXIDE GAS
CHROMITE
CLAY
COAL
COPPER
DIATOMITE
DOLOMITE
FELDSPAR
FELDSPAR & SILICA (QUARTZ)
GOLD DISTRICTS
GOLD (SMALL AREAS OR MINES)
GYPSUM
IRON
LEAD
LIMESTONE, CEMENT & MARBLE
MAGNESITE
MANGANESE
POTASH
PUMICE & VOLCANIC ASH
PERLITE
PYRITES
QUICKSILVER
SALT
SILICA (QUARTZ)
SILICA (SAND)
SILVER
SODA
SULFUR
TALC & SOAPSTONE
TITANIUM
TUNGSTEN
ZINC
GAS DISTRICTS
OIL & GAS DISTRICTS
CITIES
NOTE
COMBINED SYMBOLS SHOW TWO OR MORE MINERALS OCCUR AT SAME LOCALITY.
BORAX, SODA
COPPER, ZINC
MATEO
CLARA
SANTA CRUZ
MERCED
MADERA
SAN BENITO
FRESNO
MONTEREY
KINGS
TULARE
INYO
SAN LUIS OBISPO
KERN
SANTA BARBARA
VENTURA
LOS ANGELES
LOS ANGELES
SAN BERNARDINO
ORANGE
RIVERSIDE
SAN DIEGO
IMPERIAL
OCEAN
ARIZONA
MEXICO
NEVADA
37°
36°
35°
34°
33°
123°
122°
121°
120°
119°
118°
117°
116°
115°

CONTENTS

Page
Mineral Needs and Problems of the Bituminous Base Roofing Industry, by Dozier Finley ---------- 473
Mines and Mineral Resources of Fresno County, California, by C. A. Logan, Lewis T. Braun, and James W. Vernon ---------- 485

PLATES

Plate 31. Map of Fresno County showing location of oil fields, mines, and mineral deposits ---------- in pocket

MINERAL NEEDS AND PROBLEMS OF THE BITUMINOUS BASE ROOFING INDUSTRY

By Dozier Finley *

OUTLINE OF REPORT

	Page
INTRODUCTION	473
SPECIFICATION FOR MINERAL COMPONENTS	474
Granules	474
Asbestos	477
Fillers	478
Other Mineral Components	479
SUMMARY OF SOURCES, PRICES, QUANTITIES USED	479
Granules	479
Asbestos	481
Fillers	481
Other Mineral Components	482
AVAILABLE MINERAL COMPONENTS	483

INTRODUCTION

The asphaltic roofing industry in California dates from the decade of 1880-1890. Previous to that decade the roofing material used comprised the sawed wooden shingle, the split wooden shake, and certain quantities of sheet tin, slate, clay tile and a few other manufactured products. Some in this list are still used in considerable quantities. Forerunner of the shake or shingle was the Spanish clay tile—commonly known now as the Cordova tile; it is still made by several manufacturers and is currently used.

The native slate has been quarried, split, and applied to buildings over a wide area in California but use of it has now almost entirely ceased. The tin roof has almost disappeared, but corrugated galvanized iron, and lately corrugated aluminum, have come into the field to represent the metals. It may seem strange that a ceiling slab of reinforced concrete cannot serve as roofing slab, but concrete used as a roof deck requires waterproofing to make it an acceptable protection from the weather.

Of the several forms of roofing materials in use, the asphaltic types, the clay tile, and the asbestos-cement units are the ones employing the largest tonnage of raw materials of mineral origin.

Although asphalt itself is listed as a mineral material, derived, as it is, from quarrying operations or more commonly from petroleum, this article will deal with asphalt only briefly. This is because asphalt is not a material that the small mineral operator can easily and economically produce without embarking on an extensive program of petroleum production and marketing. The native asphalts, on the other hand, are not suitable for use in roofing either because of the lack of certain desirable qualities or because of contamination with large amounts of earthy matters.

A second component of asphaltic roofing is the felt or carrier by which the asphalt is maintained in sheet form during handling and when applied on the building roof. The felt may be of organic origin, i.e., of mixed cotton, woolen and other organic felt-making fibres, or it may be almost wholly mineral in nature, namely of asbestos fibre.

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* Research Consultant, Pabco Products, Inc. Manuscript submitted for publication July 1950.

The inorganic component of asphaltic roofings which is used in greater tonnage than any other is the colored or uncolored granular surfacing or finish applied to roofings for each of several desirable purposes. Mineral finishes used in the form of colored granules give the roofing a decorative effect. They serve a valuable utilitarian purpose in that the granular particles are opaque and hence each particle shields the asphalt immediately beneath it from the deteriorating effect of solar radiation. A third purpose which is certainly economic is that the mineral granules act as a protective agent against fire—both as a resistant layer against radiant heat from an adjacent burning structure and as a shield to protect the asphalt from the heat of blazing brands that may fall on the roof.

These are the mineral components of asphaltic roofing which make up the principal tonnage but there are others in minor quantity which are vitally important to the industry. Also there are other branches of the roofing industry which depend on asphalt and its additive mineral materials. Prominent among these are the various coatings applied to roofings to maintain them in serviceable condition. These coatings may be typified by the well-known asbestos roof coating which consists of medium short asbestos fibre mixed with a fluid composed of asphalt and volatile thinner or solvent derived from petroleum. In this group also are several coatings of the consistency of paint and composed of asphalt, (sometimes with added bituminous, waxy, or oleaginous ingredients) a pigment, and a volatile solvent. The pigment may be a natural or synthetic iron oxide of bright red color, or it may be green with a chromium oxide or hydroxide base; sometimes ochres are used. The benefit of the colored pigment is reaped when solar and weather action have destroyed the original dark color of the topmost portion of the asphaltic layer, or have removed the asphalt which overlies each pigment particle. Then the pigment particles, still anchored to underlying asphalt, are shown up in their true colors. Such paint, after weathering, transforms a black, or dark gray color of the asphaltic roof surface into a soft velvety color.

SPECIFICATIONS FOR MINERAL COMPONENTS

Granules

The granules fall into two classes:

(1) Those that are applied to sheeted roofing sold as shingles or in roll form. These granules are of the smaller size and may be regarded as a manufactured product—the output of crushers, screens, and coloring processes.

(2) Those of large size applied as a final topping to roofs built up of successive layers of felt applied to concrete and wooden roof decks; the final asphaltic coat is termed a ''flood coat'' and while it is still hot a uniform sprinkling of the large mineral granules is applied by the roofing crew. These granules may be either a local product such as screened gravel from nearby gravel pits of stream beds, or may be crushed brick, tile, waste pottery or furnace slag, or may be crushed quarry rock, or crushed rock colored with a fused ceramic glaze.

In the greater part of the United States the tar and gravel roof is commonly used where the roof slope is less than 2½ inches per foot. Tar, however, is not used as a roofing material in the Pacific area states—except for a few localities—and thus asphalt is used in the west in combination with the large granules.

Granules, Small Size. Definite specifications have been drawn up to cover the granules used on shingles and roll roofing. The first of these specification standards, D451-40, is set up by the American Society for Testing Materials.[1] This standard concerns the method of sampling, type of sieve shaker, dimensions of wire cloth in the sieves, the test procedure and the reporting of results.

The second specification bearing on this subject is also established by American Society for Testing Materials, viz: D1001-48T.[2] This specification recognizes the differences in granules made from different types of source minerals with varying characteristics in the shape of the granules, and in their weight due to the specific gravity of the parent rock. For these reasons the specification sets up three different classes of granules, designated as No. 9, No. 11, and No. 12.

Following are the specified sizes in each class of granules:

Passing	*Retained on*	*No. 9 size*	*No. 11 size*	*No. 12 size*
----------	No. 6 sieve [a]	00%	---------	---------
No. 6 sieve [a]	No. 8 sieve	00 to 10%	0%	---------
No. 8 sieve	No. 12 sieve	35 to 50%	0 to 3%	0%
No. 12 sieve	No. 16 sieve	25 to 45%	25 to 40%	15 to 30%
No. 16 sieve	No. 20 sieve	10 to 20%	30 to 45%	25 to 45%
No. 20 sieve	No. 30 sieve	0 to 5%	10 to 30%	20 to 35%
No. 30 sieve	No. 40 sieve	0 to 2% [b]	0 to 10%	10 to 20%
No. 40 sieve	No. 50 sieve	---------	0 to 2% [b]	1 to 5%
No. 50 sieve	----------	---------	---------	0 to 2% [b]

[a] Tyler sieves Nos. 6, 8, 10, 14, 20, 28, 35, and 48 are equivalent to the A.S.T.M. sieves which are above designated Nos. 6, 8, 12, 16, 20, 30, 40, and 50 respectively.

[b] This value is intended to apply to the total amount passing.

An important feature of these sieving analyses is that the low percentage in the final fraction assures the granules to be practically or completely free from dust, as dusty granules will not adhere well to the layer of hot asphalt to which they may be applied.

Hardness of the parent granule material is also to be taken into account. In general, the parent rock should have a hardness between 3.5 and 7 on the Mohs' scale. Rock which is too soft usually produces granules which are either too dusty, or which become dusty in handling operations. The upper limit is set largely by crushing difficulties or by wear and tear on handling machinery.

The crushing qualities of the rock are likewise important. Here economy of production may be a limiting factor. A rock which produces a critical percentage of unusable fines is of doubtful value unless some profitable disposal of the fines can be effected. For instance, a long rail or truck shipment of the parent rock from the quarry to the San Francisco or Los Angeles areas, where it would be crushed, might yield 50 percent granules and 50 percent unusable fines. However, crushing of the same rock at the quarry site and dumping of the fines at the mill would mean that only the 50 percent of usable granules would be subject to freight charges. But, on the other hand, the building and operation of a mill at the quarry might be attended by high construction and operating costs which would offset the anticipated advantages.

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[1] Standard method of test for sieve analysis of granular mineral surfacing for asphalt roofing and shingles (A. S. T. M. designation D451-40): Am. Soc. Testing Materials, Book of standards, pt. 3, pp. 768-770, 1949.

[2] Tentative specifications for sieve analysis of granular mineral surfacing for asphalt roofing and shingles (A.S.T.M. designation D1001-48T): Am. Soc. Testing Materials, Book of standards, pt. 3, p. 970, 1949.

Two other operations to be considered in connection with crushing and screening are oiling and coloring. For many purposes it is desirable to add oil to the granules and to distribute the oil uniformly over the total granule surface. Oil of proper grade and quality may be procured from the larger petroleum refiners. Only a small percentage of oil is used—enough to keep down dusting and to heighten the natural color of the granules.

Uncolored granules are used in minor amounts—the colors of naturally occurring rocks, with a few exceptions, are not bright enough to meet the present day demands of users. Roofing finished with natural black slate granules, however, has always had a ready sale; it is conservative in color and texture. The slate granules are flat, which is an advantage as they overlap and thus give more complete coverage to the asphalt. This was recognized as early as 1910 when E. J. Schroder applied for a patent [3] on the use of flat slate granules on roofing—he termed the slate granules ''flakes'' or ''laminae.''

Another granule used in its natural color is produced by crushing red brick. The granules are not flat, as are the slate granules, and are not produced from a natural stone, but so close is the relationship of brick to its mineralogical source that consideration of brick granules is proper in this article. It might be thought that culls and used brick might be a source for red brick granules, but long experience in producing them demonstrates that uniformity of color and quality can be obtained only by crushing and screening new brick. An exception is in the case of firebrick, sometimes crushed to produce a yellow or straw colored granule. Newly burned firebrick are too costly to be used and hence the used brick, if obtainable in quantity, may be made to serve the purpose. Most of the large roofs of the Panama-Pacific Exposition in San Francisco in 1915 were covered with roofing surfaced with a mixture of red and buff crushed brick granules.

The brick granule for roll roofing and shingles is not used to any extent at the present time. However, it is used for making imitation brick siding—a product made up of the same materials and by the same processes as are used in making roofing and shingles. The larger size of red brick granules continues to be used for surfacing built-up roofing.

Another type of granule used in the past but which is little used today is screened beach sand. Some of these sands are very attractive when viewed close up but at a distance they lack a distinctive color and texture.

Colored granules constitute the greater portion of the granules used nationally; in 1947 they made up 67.5 percent of the total sold and used.

A basic rock of good and economical crushing qualities and of neutral color is selected as the source material for the application of artificial coloring. A favorite rock for this purpose is a trap rock with not too deep a color. The process of coloring consists of applying a low fusing glaze which carries a pigment of the desired color. Typical of such pigments is chromic oxide which gives a velvety green to the completed granule, and thus to the roof. The quantity of glaze and pigment is quite small; the color, although in a very thin layer on the outer surface of each granule, is permanent.

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[3] Schroder, E. J., U. S. Patent 1,007,146, October 31, 1941.

Artificially colored granules are very satisfactory to use as the glaze has absorbed all of the dust remaining from crushing and handling. Although a great part of the colored granules formerly used in California were brought in from eastern sources, this has been changed by the erection of a plant in southern California for the production of colored granules. This plant has its own source rock and thus cannot be rated as a mere processing plant which colors granules supplied to it by the roofing manufacturer.

A roofing manufacturer may crush, screen, and even color his own granules. If there is an outlet for the fines from his crushing plant this method of operating may be carried out successfully even though the crushing plant is in an industrial center rather than at the quarry.

Course Granules for Built-up Roofs. Built-up roofs are made up of several layers of roofing felt cemented together with successive mopped coats of asphalt, and the whole flood coated with hot asphalt in which large granules of gravel, crushed mineral, crushed slag, brick, or the like are embedded. These granules range from the size of cherry stones to the size of small marbles. Where color is not a consideration, screened creek gravel is a satisfactory material. Crushed brick gives a red color, and crushed white rocks have been used. Artificial coloring may be resorted to, but usually the built-up roofs have a pitch of not over 3½ inches per foot and hence make less of a showing than the steeper roofs which are covered with ready-to-lay roll roofing or shingles. The present day tendency to build homes with almost flat roofs makes it unimportant that the roof covering shall display attractive colors. However, gravel on such roofs absorbs sun heat—it is desirable that such roofs be either insulated or that they be finished with white granules. The painting of roofs with aluminum paint made with a bituminous vehicle has given another solution to this problem.

Asbestos

Asbestos felt as a base for roofings has been used before the beginning of the present century, but in these mid-century years, the use of asbestos in roofing has become important.

Asbestos for roofing felt is of the chrysotile variety with fibres less than a quarter inch. This is characterized as the No. 5 group of fibres and may be described as falling in the range of 0-0-8-8, meaning that in a 16-ounce specimen 8 ounces should pass through the one quarter-mesh sieve and be retained on the No. 10 mesh sieve; 8 ounces should pass through the 10-mesh sieve, but this fraction should be dust free.

Asbestos fibre must make up at least 85 percent of the weight of the felt used in the roofing sheets, the remainder being sizing materials, organic fibres, moisture, etc. Amphibole fibre, which is obtainable in several places in California, is unsuited for the making of roofing felt as it is too weak and has poor felting properties. The Arizona fibre from near Globe, on the other hand, is chrysotile; it, however, is more in demand for other uses.

Even with a favorable sieve test, it is still necessary to make an actual mill run with asbestos from a new source before it can be declared satisfactory as a felt stock.

The felt for asbestos roofing with asphalt saturation is made in two weights; the lighter has a minimum weight of 8.5 pounds and 9 pounds per 100 square feet according to whether it is saturated and coated or is saturated only; the heavier has a minimum weight of 17.5 pounds per 100 square feet. The minimum thicknesses of the lighter and heavier felts are 0.020 and 0.040 inch respectively.[4]

Fillers

Another mineral component of roofings is "filler" which may be added to the asphalt coating. The filler may range from 20 to 40 percent of the top coating of the roofing. The fillers listed in one account include ground silicate rock (basic), ground silicate rock (acid), quartz, dolomitic limestone, pale slate flour, black slate flour, brick dust, carbonate, or mixtures of two or more of these.[5]

One conclusion of this report [6] is that roofing containing fine mineral filler withstood weathering better than those without filler. The tests were performed by exposing the specimens in an accelerated weathering apparatus involving exposure to heat and short wave length light from a carbon arc light and to intermittent water spray. However, certain roofing manufacturers do not subscribe to the conclusions of the report and use filler only if specified. American Society for Testing Materials permits between 15 percent and 50 percent of filler [7] in the coatings of roll roofings and shingles, reckoned on the sum of the bitumen in the coatings and the mineral matter passing the No. 100 sieve.[8]

As far as specifications are concerned, the fillers are presumably finer than 100 mesh and contain the full proportion of dust produced in grinding. Apparently the full specification would be a matter to be agreed upon by the roofing manufacturer and the producer of the mineral filler.

Diatomaceous earth is filler which has been used in the asphalt industry for more than 50 years; in that time considerable quantities have been used as filler in roofing coatings. Diatomaceous earth is extremely absorbent; it absorbs a portion of the oily constituents of the asphalt and makes a more firm composition without embrittling the product. This filler is also extremely useful in asphaltic compositions used elsewhere in the asphalt industry. It is not easy to give a specification for the most desirable type of diatomaceous earth for each specific purpose. Such a specification can best be worked out in a consultation between the producer and user of the earth.

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[4] Standard specification for asphalt-saturated asbestos felts for use in waterproofing and in constructing built-up roofs. (A.S.T.M. designation D250-47): Am. Soc. Testing Materials, Book of standards, pt. 3, pp. 965-966, 1949.

Standard specifications for asphalt-saturated and coated asbestos felts for use in constructing built-up roofs (A.S.T.M. designation D655-47): Am. Soc. Testing Materials, Book of standards, pt. 3, pp. 967-969, 1949.

[5] Snoke, H. R., and Gallup, B. E., Accelerated weathering tests of mineral-surfaced asphalt shingles: Nat. Bur. Standards Research Paper 1002, 1937.

[6] Op. cit.

[7] A revision of this A.S.T.M. requirement was made in 1950, and the manufacturer may now use filler at his own option.

[8] Tenative specifications for asphalt roofing surfaced with mineral granules (A.S.T.M. designation D249-46T): Am. Soc. Testing Materials, Book of standards, pt. 3, pp. 975-978, 1949.

Tentative specifications for asphalt roofing surfaced with powdered talc or mica (A.S.T.M. designation D224-46T): Am. Soc. Testing Materials, Book of standards, pt. 3, pp. 979-981, 1949.

Standard specifications for wide selvage asphalt roofing surfaced with mineral granules (A.S.T.M. designation D371-46): Am. Soc. Testing Materials, Book of standards, pt. 3, pp. 982-984, 1949.

Standard specifications for asphalt shingles surfaced with mineral granules (A.S.T.M. designation D225-46): Am. Soc. Testing Materials, Book of standards, pt. 3, pp. 985-987, 1949.

Standard specifications for asphalt siding surfaced with mineral granules (A.S.T.M. designation D699-46): Am. Soc. Testing Materials, Book of standards, pt. 3, pp. 988-990, 1949.

Another filler for roofing is finely fibred asbestos. The fibre may be very short but there should be no admixture of serpentine dust derived from the parent rock in which the fibre was embedded. The asphalt coating so filled is, practically speaking, unmeltable; it must be applied as a plastic, being spread by a "doctor" or flat blade. This coating is very resistant to fire, either radiant heat or falling fire brands.

Other Mineral Components

Miscellaneous uses of mineral materials in the roofing industry include use of dusting finishes to the back surface of roll roofing and shingles, sand for the selvage edge of granule-faced roll roofing, mica used as surfacing, fillers, pigments, and asbestos fibre used in roof coating paints.

Dusting Finishes. Finish for the under side of roofing and shingles is usually a low grade of talc or steatite, a mineral in the magnesium silicate or magnesium-aluminum silicate class. With the progress of the industry the type of the source rock has been changed frequently and now may contain micaceous particles in considerable percentage. A pure talc absorbs oily or waxy exudation products from the asphalt and soon takes on an unsightly brownish color when the roofing or shingles are in storage, although the later finishes correct this fault largely.

Another finish which has a long history of use in the roofing industry is finely ground mica. Although there has been considerable variation in the size of the particles used, mica for use as a roofing finish should pass through the 20-mesh sieve, with about 50 percent retained on the 48 mesh, and not more than 30 percent on the 100 mesh, not more than 10 percent on the 200 mesh, and not more than 10 percent through the 200 mesh sieve. However, good effects may be had from a somewhat coarser grinding.

There is a minor consumption of black sand, or ilmenite sand, as a finish for the exposed surface of roll roofing. Sieving of this sand should be essentially 100 percent through the 48-mesh sieve, 60 to 75 percent retained on the 100-mesh sieve and only a trace through the 200-mesh sieve. It should be free from ochre or from metallic iron which may make rust spots when the roofing is wet.

A small amount of beach sand or fresh-water sand may be used for finishing the 2-inch edge of mineral-surfaced roll roofing; this facilitates the making of a water-tight seam when the roofing is laid. The sand should pass the 35-mesh sieve and 60 to 80 percent should be retained on the 65-mesh sieve; there should be no dust, or none passing the 200 mesh.

SUMMARY OF SOURCES, PRICES, QUANTITIES USED

Granules

Natural Granules. (a) **Slate.** There are extensive outcrops of black slate in California, many of which have been worked, or at least prospected, for the production of split slates for roofing. The source rock for satisfactory slate granules may be obtained from open quarries which may be developed in or near the former workings. Generally speaking, an area may be found where substantially unlimited amounts of slate may be taken out. Also the transportation problem may not be a difficult one. The deposits are usually in the foothill regions where there is a "down hill pull" to the railroad shipping point, or, if trucking is more favorable, the product may be trucked all the way to the user's plant.

If it is more economical to crush and screen at the quarry site, disposal of the fines should not be a problem; however, it should be remembered that slate flour is marketable. A portion of the slate fines may be used in the asphaltic coating for roofing, for which it is excellently suited.

The national production of slate granules and slate flour in 1947 is reported to be 593,560 short tons [9]. As this figure is not broken down into ''granules'' and ''flour'', the slate granules are estimated to amount to about 16 percent of the granule consumption of the United States roofing industry. The value assigned to granules and flour is about $10.00 per short ton.

(b) **Brick or Tile.** The location of the source materials for these granules is, of course, a matter of the location of the brick or tile plant from which the source material is obtained. Whether the crushing and screening should take place at the kilns or at the roofing manufacturer's plant is a matter that can be solved by considering the transportation charges, the disposal of fines, and other factors involved. Insofar as quantity is concerned, the supply can be considered unlimited. Production [10] nationally in 1947 was 56,570 short tons, or about 3 percent of the total granule consumption of the United States. The value was about $17.60 per short ton.

(c) **Slag.** Under the heading of Blast Furnace Slag there is a report on granules for built up and roll roofing which shows 28,619 tons as produced in 1947—an inconsiderable amount. The value of the granules for roll roofing is given as $3.40 per ton and the value of granules for built up roofs at $1.39 per ton [11].

(d) **Natural Granules.** These are reported in the 1947 Minerals Yearbook as 504,980 short tons having a value of $4,166,810. This indicates a value of about $8.26 per ton, a figure comparing well to that given above for slate, though much higher than that for slag and lower than that given for brick.

Colored Granules. All that may be said on the location, availability, and cost of colored granules is dependent to a great extent on the location of the quarry from which the basic mineral for the granules is obtained.

Stuart H. Ingram gave an excellent summation of the problem of manufacturing [12] colored granules. The following additional figures are given in the 1947 Minerals Yearbook [13]: the artificially colored granules sold and used in the United States in 1947 totaled 1,133,870 short tons having a total value of $17,905,899 or a value of $15.80 per ton.

Due to the higher cost of the artificially colored granules, the roofing manufacturer may use natural granules on the portions of shingles which are not exposed to view. For the same reason excess colored granules returned from the roofing machines are mixed together and are used as a ''blend''. In fact, the colored granules as purchased are usually not used as such, but different colors are mixed and used as blends. Thus the manner of using these granules becomes a problem almost as intricate as the making of them.

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[9] Houk, L. G., and Downey, M. G., Slate: Minerals Yearbook, 1947, p. 1084, 1949.

[10] Runner, D. G., and Jensen, Nan C., Stone: Minerals Yearbook, 1947, p. 1107, 1949.

[11] Gwinn, G. R., Slag—iron blast-furnace: Minerals Yearbook, 1947, p. 1079, 1949.

[12] Ingram, Stuart H., Roofing granules in the southwest: California Jour. Mines and Geology, vol. 45, pp. 455-458, 1949.

[13] Runner, D. G., and Jensen, N. C., op. cit., p. 1107.

Shipping. Shipping of granules presents very few problems. They are normally shipped in bulk in box cars, or in bulk by truck. However, some is in bags, but such shipment in many parts of the country, at least, is prompted by special reasons. Protection from rain is a "must", as water in any amount is fatal to successful handling and application of the granules. Suitable mechanical unloading and conveying rigs are used to handle granules from car or truck to the roofing plant silos and thence to the roofing machines. Suction systems and blowing of granules should be avoided as certain kinds of granules tend to shatter into dust when blown through conveyor pipes.

Finishes for Built-up Roofs. Because the gravel finish for these roofs is usually from a local source, the production may be from gravel beds in creeks or from old filled-in creek channels. The sale of this material is generally to local roofing contractors and not to the roofing manufacturers. Thus the business is usually tied in with such enterprises as production of gravel for uses such as concrete aggregate or road metal. If brick is used, the sales are, like gravel, to the local roofing contractors.

The Gravellite Company, at Puente, California, is reported to specialize in the production of artificially colored granules for surfacing built-up roofs. The process used is that of fusing a ceramic glaze of the selected color to the base rock. The temperature in the kiln is about 1000° F.[14]

Asbestos

Asbestos for roofing sheets generally throughout the United States is derived from Canadian sources, which are estimated to produce 69 percent of the world's asbestos. Vermont is the only important producer south of the Canadian border. There are small or potential deposits reported in Alaska, Arizona, and California. Some of this output is unsuited to roofing manufacture. Prices for "paper stock" in 1947 ranged from $52.50 to $59.00 per short ton f.o.b. Canadian mines in United States dollars. Price of Vermont fibre of similar grading, f.o.b. Hyde Park or Morrisville, Vermont, was $65.00 to $73.00. To be added to these, of course, are both the freight on the fibre and the "conversion cost" to transform the fibre into the felt used in the roofing sheets.[15]

Some African fibre is brought into the United States but it is used for other purposes than roofing, including heat insulation, chemically resistant items, and electrical insulating materials.

Short fibre asbestos used as filler for the coating of asphalt roofings and also used, in much greater quantity, for fiberizing asphaltic coating compositions applied by brush for roofing maintenance, is generally of the chrysotile variety and is obtainable from the same sources as the paper stock fibre. The price is about $35.00 per short ton f.o.b. mine, Canada, as of 1947.

Fillers

The fillers that may be used in the coatings of shingles and roll roofing are subject to local conditions as regards supply and price.

Slate flour ranks high among the desirable fillers. Its availability in the form of flour—or in such a grading as "through 100 mesh"—would depend on the nearness of the roofing manufacturing plant to the slate deposits and the slate crushers, or on favorable freight rates. As far as other fillers are concerned it is probable that within a relatively short distance from every roofing manufacturing plant there is a commercial crusher of minerals and from him various kinds of ''fines'' are obtainable. Some roofing manufacturers, however, do not approve the inclusion of mineral fillers in the coatings of their roofings. When the costs of purchasing, handling, and mixing of fillers in asphalt and the increased cost of maintenance of equipment are considered, there is little or no saving to show for the use of such fillers. The value derived from their use depends on the moot question as to whether they confer on the roofing an increased length of serviceable life.

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[14] Op. cit.

[15] Houk, L. G., and Barsigian, F. M., Asbestos: Minerals Yearbook, 1947, p. 146, 1949.

Diatomaceous earth (diatomite) occurs in several south coastal areas as well as the northern part of California, principally in Los Angeles, Monterey, Orange, San Luis Obispo, Santa Barbara, Shasta, and Siskiyou Counties. There are many other occurrences throughout the state.[16] Oregon, Washington, and Nevada are also listed as producing states.

Other Mineral Components

There are many possible sources for soapstone or steatite in California. Grades suitable for dusting the under side of shingles and roll roofing are to be found in El Dorado, Tuolumne, and San Bernardino Counties, and Inyo County produces talc. The quantity used in the United States (this includes talc, pyrophyllite, and soapstone) by the roofing industry in 1947 is given as 63.545 short tons [17] this is about 12 percent of the total production of the three minerals. The value per ton of these three without segregation as to use was $14.89 in 1947. This may have included some packaged in bags.[18] The proportion of this material used in California for roofing manufacture probably is roughly proportional to the population in the Pacific area and is probably about one twelfth of the total tonnage. This would be about 5,300 tons which would be distributed among several roofing manufacturers in the three Pacific Coast states.

Ground mica used by the roofing industry in 1947 amounted to 40,012 short tons having a value of $1,228,972 or $30.60 per ton.[19] *Oil Paint and Drug Reporter* quotes an f.o.b. mill price of $50.00 for 20-80-mesh mica; there is really very little discrepancy between these two figures as the two are applicable to different branches of trade. Since ground mica is largely produced from scrap mica or cuttings, this portion, at least, is not a domestic product. Scrap mica from the western states is priced $6.00 to $7.00 less than imported scrap. The United States production is mostly from North Carolina and South Dakota. There is a single producer in Imperial County, California; his product is a sericite mica schist, used as a cheap grade of ground mica for roofing, as a refractory, and for other purposes.

Black sand, or ilmenite sand, is frequently found as beach sand, as at Hermosa Beach, Los Angeles County; or it may be found inland as at

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[16] Symons, Henry H., California mineral production and directory of mineral producers for 1945: California Div. Mines Bull. 137, 1946.

Averill, C. V., King, C. R., Symons, H. H., and Davis, F. F., California mineral production for 1946: California Div. Mines Bull. 139, 1948.

Oakeshott, Gordon B., Diatomite in Mineral Commodities of California: California Div. Mines Bull. 156, pp. 150-155, 1950.

[17] Johnson, B. L., and Barsigian, F. M., Talc and pyrophyllite: Minerals Yearbook, 1947, p. 1141, 1949.

[18] Op. cit., p. 1140.

[19] Gwinn, G. R., and Tucker, E. M., Mica: Minerals Yearbook, 1947, p. 787, 1949.

Sand Canyon near Saugus, in the same county. Consumption in the roofing industry is relatively small; the total production in 1943-44 in California is reported as 250 tons valued at $13.60 per ton.

AVAILABLE MINERAL COMPONENTS

In general, California is well supplied with mineral components for the manufacture of roofing; so well supplied that usually there is more than a single satisfactory source for each of the components.

The two principal components not supplied for domestic sources are asbestos and mica. These are mostly imported into the United States either as the completely graded form, or as raw scrap material. Unless there are new discoveries of these minerals, the present condition will continue indefinitely.

There are still opportunities for the production of white granules for shingles and roll roofing at a reasonable cost and in large quantity. A great deal of work has been done in this field, but the combination of unlimited supply, nearness to the point of use, satisfactory cost, permanent adhesion to the asphaltic surface and the quality of remaining clean and white under difficult conditions of service, does not yet seem to have been fully met by any of the granules so far produced from natural rock.

Aside from these items, the roofing industry does not have any pressing demands on the mineral industries. There is, of course, the perennial working of the supply-demand law with costs, improvements in quality, nearness of source to point of use, etc., but this is the normal and healthy condition of any industrial activity.

MINES AND MINERAL RESOURCES OF FRESNO COUNTY, CALIFORNIA †

By C. A. Logan,* Lewis T. Braun,** James W. Vernon **

OUTLINE OF REPORT

Page
ABSTRACT ---- 485
INTRODUCTION ---- 486
  Geography ---- 486
  History ---- 487
  Industries ---- 487
  Geology ---- 488
MINES AND MINERAL RESOURCES ---- 492
  Asbestos ---- 493
  Chromite ---- 493
  Clay products ---- 496
  Coal ---- 497
  Copper ---- 498
  Diatomite ---- 502
  Feldspar ---- 502
  Gold ---- 503
  Granite ---- 504
  Gypsum ---- 504
  Limestone ---- 506
  Magnesite ---- 509
  Manganese ---- 510
  Mercury (quicksilver) ---- 510
  Mica ---- 511
  Mineral water ---- 512
  Petroleum and natural gas ---- 514
    Introduction ---- 514
    Description of individual oil fields ---- 516
  Pumicite and pumice ---- 525
  Stone (miscellaneous) ---- 528
  Tungsten ---- 531
BIBLIOGRAPHY ---- 534
TABULATION OF MINES AND PROSPECTS ---- 537

Illustrations

Page
Figure 1. Structure sections, Panoche Hills to Chaney Ranch and Reef Ridge to North Dome ---- 519
2. Petroleum production history, Fresno County, 1895-1949 ---- 520
3. Index map of Fresno County showing oil-producing areas ---- 522
Plate 31. Map of Fresno County showing location of oil fields, mines, and mineral deposits ---- In pocket

ABSTRACT

Fresno County, which is one of the largest and most populous of central California counties, embraces 5,950 square miles, including parts of the Sierra Nevada, San Joaquin Valley, and Coast Ranges. The county's economy is dominated by agriculture and related industries. Fresno County is also one of California's leading mineral-producing counties, petroleum and natural gas accounting for more than five-sixths of the value of the county's annual mineral output. The central part of the county is occupied by the San Joaquin Valley, about 50 miles wide. The Recent alluvium of the valley is underlain by a thick series of Tertiary and Cretaceous sedimentary rocks. The valley is flanked on the west by the Diablo Range, easternmost of the

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Coast Ranges. The range is composed of a core of Franciscan (Jurassic) sedimentary volcanic and ultrabasic intrusive rocks, and the northeastward dipping rocks of the sedimentary formations underlying the valley. East of the valley granitic and older metamorphic rocks are exposed in the Sierra Nevada.

Mineral commodities currently being produced in Fresno County include petroleum, natural gas, natural gasoline and allied products, stone, clay products, pumice, limestone, and gypsum. The petroleum and natural gas-producing area lies along the western edge of the San Joaquin Valley near Coalinga. Here, oil and gas accumulations occur in anticlinal structures in Tertiary and Cretaceous sedimentary rocks. The Coalinga field has achieved the greatest production, in excess of 400 million barrels, followed by the East Coalinga field. A portion of Kettleman North Dome extends into southwestern Fresno County. Several small oil and gas fields have been discovered in western Fresno County. Monumental stone is quarried near Academy. Stone for fill and aggregate is produced primarily from stream deposits. Plants producing miscellaneous stone from gravel are located along the course of the San Joaquin and Kings river, and northwest of Avenal. The one brick plant in the county makes various shapes from a blend of local clay and clay obtained from other counties. Pumice and pumicite is produced near Friant Dam; crystalline limestone is produced in the Sierras. Marl is obtained from the Panoche Hills on the west side of the valley, as is gypsum.

Other mineral resources of the county include asbestos, chromite, coal, copper, diatomite, feldspar, gold, magnesite, manganese, mercury, mica, mineral water, and tungsten.

INTRODUCTION

Geography

Fresno County, in the central part of the state, has a width of 140 miles from east to west and embraces an area of 5,950 square miles. On the west, the summits of the Diablo Range form the boundary with San Benito County and separate the drainage toward the coast from that of the small seasonal streams entering San Joaquin Valley. The county is bordered by Merced County on the northwest, Tulare and Kings Counties on the south, Madera County on the north, and Inyo and Mono Counties on the east.

The most thickly settled part of the county is the portion lying in San Joaquin Valley. The valley occupies the larger part of the western half of the county and is served by two main-line railroads and by a network of hard-surfaced roads, including one of the principal state highways and several secondary highways.

Because of the great variations in altitude there are marked differences in climate and precipitation. The eastern half of the county rises from the valley floor, a few hundred feet above sea level, to more than 13,000 feet at the summits of the Sierra Nevada. Annual precipitation ranges from an average of 10 inches or less in the Coast Ranges and valley area to more than 60 inches in the higher mountain areas of the Sierras where most of it falls as snow. Water derived from the snow of the Sierras is vital to the lower areas of the county. The water of the San Joaquin River which had been flowing to waste until a few years ago, is now impounded behind Friant Dam, fourth largest concrete dam in the world. As a part of the Central Valleys Project of the U. S. Bureau of Reclamation, this dam and the large canals being built from it will supply much-needed water to a section of the rich agricultural land of the valley, which has always been handicapped by insufficient rainfall. The dam has a maximum height of 320 feet and a crest length of 3430 feet. It is 265 feet thick at the base, 20 feet thick at the top and contains 2,200,000 yards of concrete. It impounds water from a drainage area of 1630 square miles. Millerton Lake, formed behind the dam, is 15 miles long and has an area of 4900 acres. Its capacity is 520,000 acre-feet of water.

Kings River and its tributaries, extending to the summit region of the Sierra Nevada, drain the larger part of that region. These streams have their sources in glacial lakes. The rough country in the Kings River drainage area has few roads and no permanent residents.

History [1]

Fresno County is named for the Fresno River, which flows westward from the Sierras, discharging into the San Joaquin River below Firebaugh. The Fresno River is now in Madera County, which was formed from part of Fresno County. In Spanish, fresno means ''ash''. The river was so named by the early Spanish inhabitants because of the abundance of white mountain-ash trees along its banks. Spanish explorers first entered what is now Fresno County in the 1790's. Spaniards may have occupied the old Indian village of Pueblo de las Juntas at the confluence of the San Joaquin River and Fresno Slough as early as 1800. The old Los Angeles Trail, (El Camino Viejo) from San Pedro to what is now East Oakland, skirted the western edge of San Joaquin Valley, traversing what was to become Fresno County. Ox carts were used by the Spanish on this trail as early as 1800. In the early 1800's, an unsuccessful attempt was made by Spanish missionaries to establish a mission near Laton on Kings River, to be named Mission del Rio de los Santos Reyes (Mission of the River of the Holy Kings). Americans first entered the area in large numbers during the gold rush period following 1849. The county was created in 1856 from parts of Merced and Mariposa counties. Subsequent changes in the boundaries of the county created Madera County on the north, and yielded territory to surrounding counties until 1909, when the present boundaries were established.[2] Millerton, a mining town, was designated as the first county seat. Later the county seat was moved to Fresno. Failing to find gold in large quantities, the early settlers of the county turned to stockraising and later to farming.

Industries

Economic life of Fresno County is dominated by the growing and processing of agricultural commodities. The production of petroleum and allied products is of fundamental importance. Chief among the many agricultural commodities are grapes and raisins, alfalfa, cotton and cottonseed, and livestock. Most of the oil output is moved through pipelines to refineries in the Los Angeles and San Francisco Bay areas. Wet natural gas from the oil fields is processed in absorption and cycling plants in Fresno County to produce natural gasoline and allied products.

Water, necessary for agriculture and industry of Fresno County, is obtained from streams flowing from the Sierra Nevada and from wells. Pine Flat dam now under construction on the Kings River above Sanger will impound 1,000,000 acre-feet of water.

Low cost hydroelectric power is supplied through the transmission and distribution lines of the Pacific Gas and Electric Company from its system of generating plants in the Sierras. The following power rates are currently in effect in Fresno County (August 1950):

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[1] California Blue Book—Fresno County, p. 505, 1946.
Rench, H. E., and others, Historical spots in California—Fresno County: Stanford Univ. Press, pp. 108-119, 1933.

[2] Coy, O. C., California county boundaries—Fresno County: California Historical Survey Commission, pp. 101-106, Berkeley, 1923.

Primary Industrial Power[3]

Rate (A):

Service at standard distribution voltage of 2200 volts or more.

Demand Charge:

First 200 kw or less of maximum demand	$243.80 per month
Next 300 kw of maximum demand	$1.06 per kw per month
All over 500 kw of maximum demand	$.95 per kw per month

Energy Charge (to be added to the Demand Charge):

	Oil Field Service		*Other Service*	
	Base Rates per kwh	*Effective Rates per kwh*	*Base Rates per kwh*	*Effective Rates per kwh*
First 300 kwh per kw per month	.90¢	.97¢	.79¢	.86¢
All over 300 kwh per kw per month	.64¢	.71¢	.53¢	.60¢

Rate (B):

The rate for service from transmission lines at standard transmission voltage is the same as that set forth under Rate (A) above less 10 percent.

The above schedule is subject to special conditions including power factor and fuel clauses.

The power system of the Pacific Gas and Electric Company is joined at Piedra to the power grid of the Southern California Edison Company which serves ten southern and central California counties. The latter company has 5 hydroelectric plants on the headwaters of San Joaquin River, 55 miles northeast of Fresno, with a combined capacity of 396,000 kilowatts. Year-round output from these plants is dependent on the water stored in Florence, Huntington and Shaver reservoirs, having a combined capacity of 288,855 acre-feet.

The chief fuels used in Fresno County are natural gas and petroleum products, much of it produced in the county. Natural gas is brought from Fresno County oil fields to consuming areas by pipe lines of the Pacific Gas and Electric Company, operators of the gas distribution system. Present gas rates in the county are in the following table.

Cost of Industrial Natural Gas in Fresno County[4]

First 100 Mcf, per Mcf *	35.3¢
Next 900 Mcf, per Mcf	34.3¢
Next 2,000 Mcf, per Mcf	33.3¢
Over 3,000 Mcf, per Mcf	32.3¢

* 1000 cubic feet.

Rates apply along existing mains having delivery capacity in excess of present demands. Heat content of gas is 1050 British thermal units.

Geology

Fresno County embraces parts of three geomorphic provinces of diverse geology and topography: the Sierra Nevada, Coast Ranges, and the Great Valley of California. The Great Valley is an alluvial plain about 400 miles long, having a width of 60 miles in Fresno County. The southerly portion of the Great Valley lying in Fresno and adjacent counties is known as the San Joaquin Valley. It is flanked on the west by the northwest-trending Coast Ranges, and on the east by the rugged Sierra Nevada. The eastermost Coast Range, the Diablo Range, rises to altitudes between 2,000 and 5,000 feet near the western edge of the county. A zone of rolling foothills lies between the Diablo Range and the Great Valley. The Sierra Nevada begins near Clovis, Sanger, and Orange Cove, increasing in altitude eastward, culminating in peaks above 13,000 feet 50 miles east.

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[3] Revised California Public Utilities Commission Sheet No. 1850-E, effective April 15, 1950.

[4] Adapted from the Revised California Public Utilities Commission Sheet No. 2802-G, effective July 15, 1950.

The geology of the Sierra Nevada and the Diablo Range is quite dissimilar. The intervening valley contains its own distinctive geologic features and features in common with both the Sierras and Diablo Range. Accordingly, a description of the geology of Fresno County divides itself logically into three sections, each dealing with a geomorphic province.

Sierra Nevada Province. The Sierra Nevada has experienced a complex geologic history, which includes several periods of deposition, uplift, and erosion. A recent Division of Mines publication summarizes this history.[5] Prior to the geologically late period of uplift to which the range owes its present elevation, the Sierran area was a surface of moderately low relief. This surface was uplifted by faulting along the east flank of the present range, beginning about the end of the Pliocene epoch and continuing until the present. In effect, the surface was tilted westward, the greatest elevation being attained near the fault zone. The gently inclined western slope (about two degrees) is in sharp contrast to the steep escarpment of the east front of the range. The higher parts of the range were intensely glaciated during the Pleistocene epoch. Glaciation was carried to low altitudes by long sinuous alpine glaciers following previously cut stream valleys. Yosemite Valley is a notable example of the work of these glaciers. Following the retreat of the glaciers, swiftly flowing streams have continued to deepen these valleys.

Two major rock groups are recognized in the Sierra Nevada, the old bedrock complex and the younger overlying Superjacent series. Rocks of the bedrock complex are exposed over most of the Sierra Nevada province of Fresno County. The bedrock complex is composed principally of a batholith which has intruded a metamorphosed series of late Paleozoic and early Mesozoic volcanic and sedimentary rocks. The metamorphic rocks now remain as roof pendants projecting downward into the batholith. In general, the structure consists of tight northwest-trending folds of considerable complexity. These rocks are confined chiefly to the western portion of the Sierra Nevada province in the lower foothills, and underlying a considerable area of the younger sediments of the Great Valley.[6] Plutonic rocks of the Sierra Nevada batholith occupy most of the Sierras above 2,000 feet. These rocks range in composition from hornblende diorite to muscovite granite; quartz diorite is the most abundant rock type. Most areas of metamorphic rocks are virtually engulfed by the plutonic rocks.

Only a small amount of detailed geologic mapping has been done in the Sierra Nevada region of Fresno County. However, extensive reconnaissance mapping has been completed by Macdonald[7] in the foothill region between Kings and San Joaquin Rivers. Macdonald recognizes a series of metasediments 20,000 to 30,000 feet thick as being the oldest rocks in the area. Chief among the rocks of this series is mica schist. Minor amounts of marble, quartzite, and metavolcanics are present. Intrusion has obliterated the base of this series, but above it is at least 10,000 feet of metavolcanic rocks, chiefly amphibolites, amphibolite schists, and metarhyolite. Interbedded are metasedimentary rocks.

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[5] Jenkins, O. P., Geologic history of the Sierran gold belt: California Div. Mines Bull. 141, pp. 23-30, 1948.

[6] May, J. C., and Hewitt, R. L., The basement complex in well samples from the Sacramento and San Joaquin Valleys, California: California Jour. Mines and Geology, vol. 44, pp. 130-158, 1948.

[7] Macdonald, G. A., Geology of the western Sierra Nevada between the Kings and San Joaquin Rivers, California: California Univ., Dept. Geol. Sci. Bull., vol. 26, pp. 215-285, 1942.

A series of metasediments about 10,000 feet thick, exposed near Owens Mountain east of Friant, is believed to be the youngest of the metamorphic rocks. Sills of serpentine, emplaced just prior to the intrusion of the batholith, are common throughout the metamorphic rocks. The plutonic rocks of the batholith are the youngest rocks of the bedrock complex; they were emplaced during and following the mountain-building period, which folded and metamorphosed the earlier rocks.

The Superjacent series in this area is horizontal or gently dipping, ranging in age from Upper Cretaceous to Recent, and overlying rocks of the basement complex with profound angular unconformity. The principal rocks of the Superjacent series known in Fresno and adjacent counties are Upper Cretaceous marine sandstone, middle Eocene sandstone and conglomerate of the Ione formation, rhyolitic stream gravels and basalt flows of probable Miocene age, and Recent alluvial deposits.

Coast Range Province. Parts of the Diablo Range of the Coast Range province, and its foothills lie within Fresno County. The Diablo Range extends from Contra Costa County on the north to northwestern Kern County on the south, a distance of about 170 miles. All or parts of the following foothill areas are in Fresno County: Panoche, Ciervo, Kettleman, Guijarral, Alcalde, Jacalitos, Kreyenhagen, and San Joaquin ridge.

The core of the Diablo Range is composed of rocks of the Franciscan formation, a distinctive assemblage of rocks of Upper Jurassic age. Great areas of this core are exposed in the northern part of the range; in Fresno County this formation crops out over about 60 square miles near the crest of the range along the western boundary of the county. Rocks of the Franciscan formation are the base on which Cretaceous and Tertiary sediments of the range were deposited. These later sediments in most places dip away from the Franciscan. Fault contacts between the Franciscan and later rocks are common. On the east slope of the range, north of Oil City, the Cretaceous and Tertiary sediments dip 10 to 50 degrees northeastward toward the Great Valley. South of Oil City, structure in these sediments is complicated by northwest-trending folds, in which much of the oil known in Fresno County has accumulated. The Cretaceous and Tertiary sediments become nearly horizontal beneath the Great Valley. Figure 1 shows the structure from Escarpado Canyon in the Panoche Hills to Jergins No. 1 well in Sec. 29, T. 14 S., R. 13 E., Cheney Ranch area, adapted from Stewart,[8] and the structure in the Kreyenhagen Hills-Kettleman North Dome area near the Fresno-Kings County line, adapted from Woodring.[9] Location of structure sections are shown on figure 3. Structure sections across western Fresno County and the Coast Ranges have been published previously by the Division of Mines.[10]

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[8] Stewart, Ralph, and others, Tertiary and late Upper Cretaceous stratigraphy of the west border of San Joaquin Valley, north of Panoche Creek, Fresno, Merced, and Stanislaus Counties, California: U. S. Geol. Survey, Oil and Gas Investigation ser. Prelim. Chart 6, 1944.

[9] Woodring, W. P., and others, Geology of the Kettleman Hills oil field, California: U. S. Geol. Survey, Prof. Paper 195, pl. 15, 1940.

The Franciscan formation is composed chiefly of arkosic sandstone, shale, basalt, chert, and ultrabasic intrusives. Most of the ultra-basic rocks have been altered to serpentine. Characteristic rocks of this formation are serpentine and hard green sandstone. The Franciscan formation has been discussed at length by Taliaferro.[11]

The post-Franciscan rocks of the eastern Coast Ranges have received the unrelenting attention of a virtual army of geologists for many years, because of their great oil-producing potential. The general remarks and structure sections presented above outline the geology of the Diablo Range and adjacent parts of the Great Valley in Fresno County. For the reader desiring additional detailed information of the geology of the area the following publications are suggested; additional references are contained in the bibliography accompanying the present report.

1. Anderson, Robert, and Pack, R. W., Geology and oil resources of the west border of the San Joaquin Valley north of Coalinga, California: U. S. Geol. Survey, Bull. 603, 220 pp., 14 pls., 5 figs., 1915.
2. Woodring, and others, Kettleman Hills oil field, op. cit.
3. Jenkins, O. P., and others, Geologic formations and economic development of oil and gas fields of California: California Div. Mines Bull. 118, 773 pp., 6 pls., 1 map, 81 index maps, 296 figs., 1943 (contains descriptions of principal oil fields of Fresno County and general geology).
4. Stewart, Ralph, and others, Tertiary and late Upper Cretaceous stratigraphy, op. cit.

The Great Valley of California. Structurally the Great Valley is a broad geosyncline of Upper Cretaceous and Tertiary sediments. Rocks underlying most of the valley are essentially flat-lying. Local warping of the beds and irregularities of sedimentation have formed traps in which oil and natural gas have accumulated. The axis of the geosyncline lies somewhere near the west edge of the valley. In the axial region of Fresno County it is estimated that these sediments are at least 25,000 thick; eastward they become progressively thinner. Bedrock beneath the deeper portions of the syncline has not been reached by drilling; however, many holes drilled in the eastern part of the valley indicate that rocks related to the bedrock complex of the Sierra Nevada underlie the sedimentary series throughout much of the valley.[12]

The most westerly occurrence of bedrock has been reported from a drill hole near Riverdale, where steeply dipping, hard, dark shale was identified as of questionable Triassic age,[13] probably correlative with rocks of the Sierran province. The west limb of the Great Valley syncline rests upon rocks of the Franciscan formation. The structural relationships beneath the valley between the Franciscan rocks and those of the Sierran type are unknown.

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[10] Taliaferro, N. L., Geologic history and structure of the central Coast Ranges of California: California Div. Mines, Bull. 118, p. 162, 1943.

[11] Taliaferro, N. L., Franciscan-Knoxville problem: Am. Assoc. Petroleum Geologists Bull., vol. 27, pp. 109-219, 1943.

[12] May, J. C., and Hewitt, R. L., The basement complex in well samples from the Sacramento and San Joaquin Valleys, California: California Jour. Mines and Geology, vol. 44, pp. 130-155, 1948.

[13] May, J. C., and Hewitt, R. L., op. cit., p. 146.

MINES AND MINERAL RESOURCES

Fresno County has ranked third in value of annual mineral production among California counties since 1943, being exceeded by Kern and Los Angeles Counties. Production during 1948 reached an all-time high approaching $124,500,000; petroleum and associated natural gas products amounted to $122,700,000 of this total. The pronounced increase of the value of annual mineral production from Fresno County in the post-war years is almost wholly the result of the advance of petroleum prices. In 1947 slightly more than 44,000,000 barrels of crude petroleum, valued at $75,500,000 was produced. A modest production increase to 45,800,000 barrels in 1948 brought the value of the output to about $112,000,000. The removal of the government war-time ban against gold mining revived the operation of suction dredges on the San Joaquin River. The mining of agricultural marl and gypsum from the Coast Range foothills in Fresno County are interesting post-war developments. These operations were stimulated by federal incentive payments to farmers to improve their soil. Output of tungsten from Fresno County mines was curtailed when in July 1944 the Metals Reserve Company discontinued their premium price of $30.00 per unit of WO_3 to new operators. Value of tungsten output dropped from $204,624 in 1944 to $15,858 in 1948. Mercury output was similarly affected by the rapid price decline following the war.

Fresno County has also produced commercially asbestos, copper, chromite, diatomite, feldspar, gems, lead, limestone and marl, magnesite, mineral water, platinum, pumice and quartz. The total value of recorded mineral production of Fresno County through 1948 is $905,000,000, not including natural gasoline and allied products.

*Fresno County mineral production for 1947 and 1948**

	1947		1948	
	Quantity	Value	Quantity	Value
Clay products, heavy clay (other than pottery and refractories)	------------	[2]	------------	[2]
Gold......troy ounces	235	8,225	[3]	[3]
Gypsum, crude......short tons	[1]	[1]	15,443	23,271
Mercury......flasks	[1]	[1]	------------	------------
Natural gas......Mcf.	65,636,000	6,943,000	69,644,000	7,224,000
Natural gasoline and allied products:				
Natural gasoline[3]......gallons	75,488,000	3,990,000	26,623,000	2,199,000
Liquefied petroleum gases[3]......gallons	41,170,000	1,642,000	22,262,000	1,400,000
Petroleum......barrels	44,137,000	75,560,000	45,841,000	111,920,000
Sand and gravel......short tons	1,031,322	1,141,346	932,804	1,022,024
Silver......troy ounces	37	33	[1]	[1]
Stone......short tons	164,910	292,835	416,530	618,459
Tungsten concentrates (60% WO^3 basis)......short tons	[1]	[1]	11	15,858
Unapportioned (raw clay and items indicated by footnote 1)	------------	48,768	------------	27,890
Total value	------------	89,626,207	------------	124,450,502

* These figures are furnished by the United States Bureau of Mines in cooperation with the California State Division of Mines.

[1] Value included with "Unapportioned."

[2] U. S. Bureau of the Census not at liberty to publish figure. Value not included in county total.

[3] Natural gasoline and liquefied petroleum gases processed in Kettleman Hills oil field came from gas produced in both Kings and Fresno Counties.

The following is a list of minerals noted in Fresno County:[14]

- Acmite-aegirite
- Analcime
- Anauxite
- Andalusite
- Apatite
- Argentian
- Arsenopyrite
- Berkevikite
- Beryl
- Bindheimite
- Bismuthinite
- Bismutite
- Bornite
- Brucite
- Calcite
- Chalcanthite
- Chalcedony
- Chalcocite
- Chalcopyrite
- Chromite
- Clinochlore
- Clinohumite
- Collophane
- Cuprotungstite
- Diamond
- Diopside
- Epidote
- Ferrimolybdite
- Galena
- Garnet
- Graphite
- Gypsum
- Hedenbergite
- Hematite
- Idocrase
- Magnesite
- Magnetite
- Molybdenite
- Natrolite
- Opal
- Phlogopite
- Potash alum
- Psilomelane
- Pyrrhotite
- Rhodonite
- Rutile
- Serpentine
- Scheelite
- Sphene
- Silver
- Spinel
- Tenorite
- Topaz
- Tourmaline
- Tremolite
- Vermiculite
- Wollastonite
- Zircon

Asbestos

Tremolite asbestos has been reported near Minkler and 30 miles east of Sanger. No work has been done recently on either of these prospects, and no one was found during field work who could give the definite location of either prospect.

Ross-Garcia asbestos claims, including nine locations and a mill-site are in sec. 21, T. 19 S., R. 13 E., about 19 miles northwest of Coalinga. R. Moon, Hanford, was the principal owner at the time prospecting was done a few years ago.

These claims, which were worked by open cuts, contain much short-fiber asbestos and some as much as $\frac{3}{4}$ inch long.

Chromite

Chromite production from Fresno County prior to 1919 amounted to about 19,000 tons. As in many counties of the state, most of the better grade massive chromite ore was removed between 1915 and 1919 under the stimulus of wartime prices. From 1919 to 1940 there was little if any production. The recorded output between 1940 and 1945 inclusive was about 2350 tons. The largest producer was the Clara H mine, with a reported output of 6000 to 8000 tons. The Lacey mine has had a total reported production of 3725 tons. Both mines are in the NW$\frac{1}{4}$ sec. 25, T. 11 S., R. 23 E. Eighteen other properties have produced more than 150 tons of chromite. More than 70 deposits have been discovered in Fresno County. The ore remaining in these deposits is mostly low grade and disseminated, requiring concentration. The chromite deposits are in the Hog Mountain region, in a belt of peridotite and serpentine about 1 mile wide extending northwestward across Hog Mountain from sec. 19, T. 12 S., R. 25 E. to sec. 13, T. 11 S., R. 23 E. All of these chromite mines and prospects have been described in a recent bulletin,[15] which includes a map. The accompanying map (pl. 1) shows the location of the 20 mines which have produced more than 150 tons of chromite.

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[14] Murdoch, Joseph, and Webb, Robert W., Minerals of California: California Div. Mines, Bull. 136, 408 pp., 1948.

[15] Rynearson, G. A., Chromite deposits of Tulare and eastern Fresno Counties, California: California Div. Mines Bull. 134, pt. III chap. 3, 104 pp., 1948.

MINERAL PRODUCTION O

Year	Gold, value	Silver, value	Copper		Petroleum		Brick		Miscellaneous stone,[1] value
			Pounds	Value	Barrels	Value	M	Value	
1880	$143,433	----------	----------	----------	----------	----------	----------	----------	----------
1881	90,000	----------	----------	----------	----------	----------	----------	----------	----------
1882	80,000	----------	----------	----------	----------	----------	----------	----------	----------
1883	100,000	----------	----------	----------	----------	----------	----------	----------	----------
1884	80,000	----------	----------	----------	----------	----------	----------	----------	----------
1885	74,500	$2,456	----------	----------	----------	----------	----------	----------	----------
1886	151,186	2,701	----------	----------	----------	----------	----------	----------	----------
1887	205,242	274	----------	----------	----------	----------	----------	----------	----------
1888	200,000	2,800	----------	----------	----------	----------	----------	----------	----------
1889	185,988	4,629	----------	----------	----------	----------	----------	----------	----------
1890	49,951	1,816	----------	----------	----------	----------	----------	----------	----------
1891	82,607	10,396	----------	----------	----------	----------	----------	----------	----------
1892	[2]112,981	[2]6	----------	----------	----------	----------	----------	----------	----------
1893	7,118	----------	----------	----------	----------	----------	----------	----------	----------
1894	8,202	----------	----------	----------	----------	----------	----------	----------	----------
1895	47,249	----------	----------	----------	----------	----------	----------	----------	----------
1896	28,235	100	----------	----------	14,119	$56,750	----------	----------	----------
1897	43,144	----------	----------	----------	70,140	70,840	----------	----------	----------
1898	27,557	----------	----------	----------	154,000	154,000	2,500	$18,000	----------
1899	18,142	----------	----------	----------	439,372	439,372	5,500	38,500	----------
1900	22,346	479	----------	----------	547,960	547,960	4,250	35,062	----------
1901	21,462	----------	1,159,672	$182,648	525,433	236,444	5,000	35,000	----------
1902	54,427	----------	3,000,000	345,000	571,233	199,931	6,000	45,000	----------
1903	21,538	111	----------	----------	2,214,160	730,673	8,000	68,000	$11,03
1904	7,809	4	2,500	319	5,114,958	1,520,847	4,800	32,400	----------
1905	40,037	9,187	1,440,000	224,640	8,890,000	2,400,300	9,000	60,000	----------
1906	8,493	83	440,000	88,000	8,402,000	1,974,470	8,000	64,000	----------
1907	2,401	26	250,000	50,000	9,050,300	3,620,120	9,230	57,350	10,50
1908	1,054	11	----------	----------	10,725,389	5,898,964	13,220	106,960	16,90
1909	17,539	8,503	876,837	111,341	15,406,619	9,243,971	7,950	49,375	28,40
1910	3,373	2,980	486,725	61,999	18,651,470	9,277,241	9,533	76,267	58,08
1911	17,441	81	----------	----------	19,499,611	9,344,085	4,500	28,500	318,91
1912	6,094	23	----------	----------	19,510,932	8,487,255	5,000	40,000	307,15
1913	2,846	15	----------	----------	18,956,965	7,927,736	5,500	44,000	416,43
1914	10,231	31	----------	----------	15,952,190	7,210,389	4,500	36,000	237,96
1915	4,151	246	65,903	11,533	14,021,025	7,641,459	4,750	33,250	193,70
1916	693	69	29,173	7,177	14,594,246	7,530,631	[3]	----------	95,83
1917	5,745	289	40,662	11,101	16,259,797	13,414,333	[3]	----------	136,71
1918	4,795	37	----------	----------	16,068,919	19,138,083	and tile	89,156	244,64
1919	5,540	67	----------	----------	16,091,037	20,805,711	[3]	----------	241,21
1920	7,793	227	----------	----------	15,375,454	22,801,798	12,517	196,756	535,58
1921	13,085	75	----------	----------	12,161,565	18,643,679	[3]	----------	486,05
1922	10,442	87	----------	----------	9,265,529	9,895,582	----------	220,737	600,34
1923	18,519	128	----------	----------	5,061,542	3,593,695	[3]	----------	863,08
1924	32,978	190	----------	----------	10,156,405	11,801,743	----------	95,104	451,54
1925	25,056	151	----------	----------	7,773,665	8,503,390	[3]	----------	457,30
1926	8,595	52	----------	----------	7,340,102	5,982,183	----------	87,493	388,55
1927	17,406	77	----------	----------	7,202,284	5,977,176	----------	89,145	1,118,70
1928	15,455	75	[3]	----------	4,611,440	3,524,985	[3]	----------	362,26

ESNO COUNTY, 1880-1948

Mineral water		Magnesite		Natural gas[22]		Miscellaneous and unapportioned		
llons	Value	Tons	Value	M cu. ft.	Value	Amount	Value	Substance
-----	-----	-----	-----	-----	-----	-----	-----	
-----	-----	-----	-----	-----	-----	-----	-----	
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-----	-----	-----	-----	-----	-----	-----	-----	
-----	-----	-----	-----	-----	-----	216 tons 500 tons	$700 4,000	Coal. Gypsum.
-----	-----	-----	-----	-----	-----	600 tons	4,800	Gypsum.
1,200	$400	-----	-----	-----	-----	50 tons	400	Gypsum.
1,886	350	-----	-----	-----	-----	-----	-----	
2,000	900	-----	-----	-----	-----	100 tons	600	Gypsum.
2,000	900	-----	-----	-----	-----	16 tons	320	Asphalt.
5,000	4,000	-----	-----	-----	-----	-----	268,534	Unapportioned, 1900-1909.
5,142	5,142	-----	-----	-----	-----	-----	-----	
5,000	4,500	-----	-----	-----	-----	-----	-----	
7,200	7,200	-----	-----	-----	-----	839 tons	10,068	Asphalt.
4,800	2,400	38	$120	-----	-----	579 tons	6,948	Asphalt.
-----	-----	-----	-----	-----	-----	-----	-----	
-----	-----	-----	-----	-----	-----	-----	-----	
-----	-----	-----	-----	-----	-----	-----	-----	
-----		-----	-----		-----	500 tons 9,000 tons	5,500 26,000	Asphalt. Clay.
-----	-----	850	8,500	-----	-----	400 tons	4,400	Asphalt.
-----	-----	1,400	22,400	-----	-----	200 tons -----	2,600 750	Asphalt. Gems.
-----	-----	220	2,195	-----	-----	-----	250	Gems.
-----	-----	2,000	20,000	200,000	$21,380	50 tons ----- 336 flasks	950 700 14,125	Chromite. Gems. Quicksilver.
-----	-----	1,135	9,080	236,100	23,610	375 flasks	15,086	Quicksilver.
-----	-----	-----	-----	250,000	15,000	148 flasks	7,259	Quicksilver.
-----	-----	-----	-----	2,894,834	253,906	1,300 tons -----	13,600 450	Chromite. Other minerals.
[3]	-----	5,829	49,082	2,346,917	163,941	9,060 tons 11,000 cu. ft. 668 lbs. -----	151,824 25,000 46 36,900	Chromite. Granite. Lead. Brick, fuller's earth, minera water.
[3]	-----	6,077	57,422	4,097,626	347,501	6,289 tons ----- -----	109,292 31,500 44,150	Chromite. Granite. Asbestos, brick, mineral water, quicksilver.
-----	-----	1,795	16,151	5,009,327	267,123	2,314 tons ----- 35 flasks	86,181 26,800 3,652	Chromite. Granite. Quicksilver.
-----	-----	600	5,950	5,191,287	411,356	----- -----	34,500 140,128	Granite. Chromite and brick.
-----	-----	906	8,725	3,721,313	201,865	----- -----	49,600 17,000	Granite. Other minerals.
-----	-----	945	9,540	1,886,081	190,181	----- ----- -----	125,276 28,610 2,000	Clay and clay products. Granite. Other minerals.
-----	-----	-----	-----	1,694,090	89,277	----- ----- -----	28,600 8,360 217,880	Granite. Other minerals. Clay and clay products.
-----	-----	-----	-----	1,599,354	122,702	----- -----	64,920 2,400	Granite. Other minerals.
-----	-----	-----	-----	1,430,708	102,286	----- -----	60,447 3,600	Granite. Other minerals.
-----	-----	-----	-----	1,515,889	116,711	----- -----	63,580 98,801	Granite. Clay and clay products, mineral water.
[3]	-----	-----	-----	1,920,489	153,726	17,880 cu. ft. -----	78,624 800	Granite. Other minerals.
-----	-----	-----	-----	1,682,652	148,227	17,186 cu. ft. -----	74,424 2,000	Granite. Other minerals.
[3]	-----	-----	-----	1,422,366	151,061	1,376 cu. ft. -----	80,050 93,400	Granite. Other minerals.[4]

MINERAL PRODUCTION

Year	Gold, value	Silver, value	Copper		Petroleum		Brick		Miscellaneou stone, value
			Pounds	Value	Barrels	Value	M	Value	
1929	$13,575	$79	3	----------	3,498,107	$1,781,586	3	----------	$301,
1930	5,916	21	3	----------	3,362,902	1,910,128	3	----------	3
1931	6,512	15	3	----------	2,991,976	1,649,476	3	----------	202,
1932	12,445	32	3	----------	3,665,641	2,038,096	3	----------	116,
1933	19,459	48	3	----------	4,516,246	2,586,906	3	----------	59,
1934	24,066	87	3	----------	6,607,661	4,295,980	3	----------	3
1935	20,645	119	3	----------	27,697,545	26,047,611	3	----------	161,
1936	15,225	74	3	----------	30,035,864	36,317,189	3	----------	175,
1937	8,540	43	3	----------	29,091,322	36,521,804	3	----------	187,
1938	10,955	35	3	----------	20,784,106	26,201,849	----------	----------	224,
1939	16,100	58	3	----------	15,411,056	18,077,169	----------	----------	293,
1940	34,400	164	3	----------	17,377,685	18,562,902	----------	----------	197,
1941	214,060	694	3	----------	20,302,492	19,560,723	3	----------	264,
1942	40,810	143	----------	----------	23,959,303	21,206,580	3	----------	391,
1943	1,260	3	----------	----------	37,869,219	37,779,881	----------	----------	257,
1944	5,425	13	----------	----------	45,325,244	46,159,669	3	----------	431,
1945	4,095	12	----------	----------	44,370,645	47,822,774	3	----------	735,
1946	9,520	34	----------	----------	42,645,954	53,357,732	3	----------	677,
1947	8,225	33	----------	----------	44,137,000	75,560,000	3	----------	3
1948	3	3	----------	----------	44,841,000	111,920,000	3	----------	3
Totals	$2,614,112	$50,252	----------	$1,093,758	779,152,829	$817,953,851	----------	$1,645,965	$12,258,

Grand total value, $905,046,538.

[1] Includes crushed rock, rubble, rip-rap, sand, gravel.

[2] To end of 1892, includes Madera County, which was created March 11, 1893.

[3] See under "Unapportioned."

[4] Brick and hollow building tile, copper, gems, mineral water, pumice, quicksilver.

[5] Brick and hollow building tile, copper, diatomite, gems, mineral water, volcanic ash.

[6] Brick and hollow building tile, diatomite, granite, gypsum, mineral water, volcanic ash, miscellaneous stone.

[7] Brick and hollow building tile, chromite, diatomite, gems, granite, gypsum, marl, mineral water, quicksil volcanic ash.

[8] Brick and hollow building tile, diatomite, gems, granite, gypsum, marl, mineral water, quicksilver, volcanic ash.

[9] Brick and hollow building tile, pottery clay, diatomite, granite, gypsum, marl.

[10] Brick and hollow building tile, clay (pottery), copper, diatomite, gems, granite, gypsum, limestone (marl), cellaneous stone.

[11] Brick and hollow tile, chromite, copper, diatomite, granite, limestone, quicksilver.

Clay Products

No extensive commercial deposits of high-grade clay have been reported in Fresno County. Some of the valley hardpan and silt have been used for making brick and tile, but it is necessary to mix clay shipped from other counties with the local material in order to obtain proper plasticity. Only one plant has reported production since 1928, except for some production of oil-well drilling mud from the Coalinga district in 1936.

Craycroft Brick Company, Belmont and Lafayette Streets, Fresno, has operated at its present site for many years. The plant is 3 miles west of state highway 99. Mrs. F. J. Craycroft is president. The plant has been previously described [16] and Mrs. Craycroft stated she did not wish to add anything to that report. Only part of the clay used at the plant is

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[16] Dietrich, W. F., The clay resources and ceramic industry of California: California Min. Bur. Bull. 99, p. 78, 1928.

ESNO COUNTY, 1880-1948—Continued

Mineral water		Magnesite		Natural gas[22]		Miscellaneous and unapportioned		
allons	Value	Tons	Value	M cu. ft.	Value	Amount	Value	Substance
[3]	--------	--------	----------	1,006,110	$190,598	------------ 10 flasks ------------	$28,000 1,190 13,600	Granite. Quicksilver. Other minerals.[5]
[3]	--------	--------	----------	393,337	26,108	174 flasks ------------	13,418 368,882	Quicksilver. Other minerals.[6]
[3]	--------	--------	----------	5,591,304	253,937	------------	125,645	Other minerals.[7]
[3]	--------	--------	----------	25,476,752	1,520,285	------------	57,039	Other minerals.[8]
[3]	--------	--------	----------	18,807,454	1,191,237	34 flasks ------------	1,541 42,549	Quicksilver. Other minerals.[9]
[3]	--------	--------	----------	19,680,080	1,235,707	30 flasks ------------	1,208 215,759	Quicksilver. Other minerals.[10]
-----	--------	--------	----------	63,579,904	3,687,049	6,633 tons ------------	19,899 79,603	Gypsum. Other minerals.[11]
-----	--------	--------	----------	60,983,263	3,582,394	71 flasks ------------	5,362 149,730	Quicksilver. Other minerals.[12]
-----	--------	--------	----------	67,274,419	4,308,280	------------	152,745	Other minerals.[13]
[3]	--------	--------	----------	58,337,848	3,626,724	------------	95,086	Other minerals.[14]
-----	--------	--------	----------	54,485,085	2,799,981	------------	88,907	Other minerals.[15]
-----	--------	--------	----------	61,400,088	3,139,902	------------	169,196	Other minerals.[16]
-----	--------	--------	----------	68,694,072	3,468,495	183 flasks ------------	31,909 211,142	Quicksilver. Other minerals.[17]
-----	--------	--------	----------	59,828,203	2,946,323	2,236 units ------------	50,260 154,512	Tungsten ore. Other minerals.[18]
-----	--------	--------	----------	48,944,169	2,793,749	32 flasks 2,888 units ------------	5,980 79,165 122,247	Quicksilver. Tungsten ore. Chromite, feldspar, gems, granite.
-----	--------	--------	----------	32,686,565	2,836,676	8,280 units ------------	204,624 163,221	Tungsten ore. Other minerals.[19]
-----	--------	--------	----------	46,897,552	2,832,579	------------	282,198	Other minerals.[20]
-----	--------	--------	----------	55,454,786	4,806,207	------------	354,048	Other minerals.[21]
-----	--------	--------	----------	65,636,000	6,943,000	------------	1,482,949	Other minerals.[23]
-----	--------	--------	----------	69,644,000	7,224,000	------------	1,707,502	Other minerals.[24]
4,288	$25,792	21,795	$209,165	921,900,024	$62,184,084	------------	$8,657,441	

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[12] Brick and hollow tile, chromite, clay (oil well drilling mud), copper, feldspar, gems, granite, gypsum, limestone, rtz.

[13] Brick and hollow tile, chromite, clay (oil well drilling mud), copper, feldspar, granite, gypsum, limestone, quicksilver.

[14] Brick and hollow tile, chromite, pottery clay, feldspar, gems, granite, gypsum, limestone, mineral water, quicksilver, gsten ore.

[15] Brick, pottery clay, feldspar, gems, mineral water, gypsum, granite, limestone, quicksilver, tungsten ore.

[16] Brick and hollow tile, chromite, pottery clay, coal, feldspar, granite, gypsum, quicksilver, tungsten ore.

[17] Brick and hollow tile, chromite, copper, gems, granite, gypsum, platinum, tungsten ore.

[18] Brick and hollow tile, chromite, clay, feldspar, granite, quicksilver.

[19] Brick and hollow tile, chromite, clay, feldspar, granite.

[20] Brick and hollow tile, chromite, clay, granite, quicksilver, tungsten ore.

[21] Brick and hollow tile, gypsum, limestone, quicksilver, tungsten ore.

[22] Natural gasoline and allied products not included in tabulation.

[23] Brick and hollow tile, clay, granite, gypsum, stone (miscellaneous), tungsten ore.

[24] Brick and hollow tile, clay, granite, gypsum, stone (miscellaneous), tungsten ore.

dug from a shallow deposit of hardpan on the property, according to her statement. The rest is purchased from clay producers in other counties. The products made include common brick, hollow tile, floor, drain and roofing tile, some fire brick, clinker and paving brick, all ranging from light to dark red; also special shapes and sizes and such as Franklin, Norman smooth face, and Roman brick (some buff) and buff flue lining.

Coal

Lignite has been known for many years both northwest and southwest of Coalinga along the eastern slope of the Coast Ranges. Priest Valley coal field is partly in the extreme southwest part of Fresno County in T. 20, 21, and 22S and in R. 12, 13 and 14 E. Most of the work in this field, however, has been done in Monterey County at the Stone Canyon mine. Some work was done in the 1890's in sec. 6, T. 22 S., R. 14 E. about 3½ miles southwest of Parkfield Junction, Fresno County.

The Coalinga coal field, from which the town took its name long before oil was discovered in the district, has been developed principally at the California and San Joaquin coal mines 3 to 4 miles northwest of Coalinga. These two mines were operated in the 1880's and one of them made some production as late as 1896. The mining operations there have been described in detail.[17] Very little work has been done on any of the coal deposits since 1896. Watts [18] collected fossils from the two above-named mines in 1893, and stated that these were classified as Eocene.

No statistics are available to indicate the amount of production from the Fresno County coal mines, except for the year 1896, when the county is credited with 216 tons of coal, and it has been stated that the San Joaquin mine produced in 1894 at the rate of 300 tons a month. The coal was evidently marketed in Fresno and nearby and it is probable that total production was not large.

The following list shows the location of the lignite deposits on which some work has been done in Fresno County:

California coal mine, sec. 22, T. 20 S., R. 14 E., is about 3 miles northwest of Coalinga and at an elevation of about 1300 feet. This mine was first worked through a series of adits and later by 400-foot incline. It is the only coal mine on which any work has been done since 1896. In July 1940, M. J. Raney leased the property from E. M. Einstein, the owner, and produced a small amount of lignite.

Carey Creek coal prospect is in sec. 16, T. 22 S., R. 14 E. This was being prospected in 1894 when a landslide covered the prospect cut. After the slide an adit was started to open the coal vein in another place. This work was soon abandoned.

Del Monte or Drabble mine is in sec. 26, T. 20 S., R. 12 E., 16 miles west of Coalinga at an elevation of about 2400 feet. This mine was worked by adits, the lowest of which was 390 feet long in 1896.

San Joaquin Valley Company's coal mine is on the west side of sec. 26 T. 20 S., R. 14 E., at an elevation of about 1100 feet. This was the most extensively worked of the Fresno County coal mines. It had adits 300, 400, and 1700 feet long and an incline 300 feet long. It contained several small seams of inferior lignite three to seven inches thick and a seam 4½ feet thick.

Warthan Creek prospects are on the south side of Warthan Creek in T. 21 S., R. 13 E. Only surficial work has been done here. In sec. 12 of this township, however, two seams, one 3 feet and one 1½ feet thick, have been superficially prospected.

Copper

Little activity has been noted in recent years at any of the copper prospects in this county. The only mine with any substantial record of copper production in Fresno County is the Copper King, which was active principally between 1900 and 1910, with some production from 1915 to 1917. Favorable economic conditions during World War II, when other Foothill Copper Belt mines were active, failed to prompt

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[17] Goldstone, L. P., Fresno County: California Min. Bur. Rept. 10, pp. 186-187, 1889-1890.
Watts, W. L., Fresno County: California Min. Bur. Rept. 11, pp. 217-218, 1892.
Mathyas, F. C., Fresno County: California Min. Bur. Rept. 12, pp. 50-54, 1893-94.
Mathyas, F. C., Fresno County: Cailfornia Min. Bur. Rept. 13, p. 53, 1896.

[18] Watts, W. L., Oil and gas yielding formations of California: California Min. Bur. Bull. 19, p. 139, 1900.

*Analysis of Fresno County coal**

Locality	Color of powder	Color of ash	Coking qualities	Water	Volatile matter	Fixed carbon	Ash	Authority
San Joaquin Mine-Little vein	Glistening black, brown tinge	Reddish	None	12.00	37.75	39.75	10.50	Mathyas
Big vein	Glistening black, brown tinge	White	None	11.25	40.25	31.25	17.25	Mathyas
California Mine-Little vein				13.25	41.75	35.00	10.00	Mathyas
1.000 ft. in.	Glistening black, brown tinge	White		11.25	48.50	31.40	8.85	Dr. W. D. Johnston

* Mathyas, F. C., Analyses of California coals: California Min. Bur. Rept. 12, p. 64, 1893-94.

the reopening of any Fresno County copper mines. Several copper mines of the Foothill Copper Belt, formerly in Fresno County, are now in Madera County, which was formed from the northern part of Fresno County in 1893.

Most of the work has been done at mines and prospects in the Foothill Copper Belt, but copper occurs in the ores of some of the gold mines farther east in the mountains, and in the higher region near the summits of the Sierra Nevada. The geology of mines in the Foothill Copper Belt is similar to that of mines farther north on the same belt, the ore being associated with amphibolite schist and interbedded metasediments (Jurassic), notably mica schists. Chalcopyrite, the principal copper mineral, occurs with large amounts of pyrite and pyrrhotite in quartz veins and stringers, and in masses and fahlbands in the amphibolite schist. Some zincblende is reported, and from ore shipped from one mine, small amounts of gold and silver were recovered. The principal mine workings have been closed for years so that no detailed examination is possible.

A recent tabulation of copper mines in Fresno County[19] lists 21 properties; two of these produced more than 1,000,000 pounds of copper (Copper King and Fresno); one, the Painter mine, produced 100,000 to 1,000,000 pounds. Three mines, the Neiper, Post Oak, and Uncle Sam, produced less than 100,000 pounds. No production is recorded for the other properties. The productive copper properties are included in the tabulated list of mines and are located on the map accompanying this report.

Copper King mine originally consisted of one claim at an elevation of 1500 feet in the SE¼ sec. 3, T. 12 S., R. 23 E., on Dog Creek. Considerable work had been done by the early 1890's. The iron gossan carried little or no copper, but chalcopyrite with some galena, zincblende and gold were found in a vein at shallow depth. By 1896, when the claim was sold to a British company, the ore body had been opened for 450 feet in length and a maximum width of 28 feet of ore was claimed. In 1900 the Copper King claim, 19.58 acres, was patented. The property was later made the basis of a London company called Copper King, Limited. This company built a smelter on Suisun Bay, Contra Costa County, and also spent large sums at the mine. Although in 1901 and 1902 they produced 4,159,672 pounds of copper, the company failed and went into receivership in 1903. From 1904 to 1907, C. C. Leavitt operated the mine for the benefit of the creditors and produced most of 2,132,500 pounds of copper credited to Fresno County during that time. The vein that yielded this ore was 16 feet wide (average?) and yielded 8 percent copper.[20] In June, 1907 the Hart Mining Company bought the mine at court sale for about $44,000 and produced during the rest of that year. The main shaft reached a depth of nearly 800 feet and an inclined shaft was about 700 feet deep. There were six levels totalling over 2500 feet in length.

The work at this mine led to the location of 13 claims by Wabash Mining Company. These claims, containing 224.97 acres, were patented in 1908 as the Wabash No. 1 to No. 13 inclusive. They completely surround the Copper King mine and extend for more than 6400 feet across the S½ sec. 3, T. 12 S., R. 23 E., and into adjoining parts of secs. 2, 10 and 11. All of these claims were merged with the Copper King mine in 1917 for promotion purposes.

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[19] Eric, J., Tabulation of copper deposits of California *in* Copper in California: California Div. Mines Bull. 144, pp. 232-234, 1948.

[20] Copper resources of California: California Min. Bur. Bull. 50, p. 282, 1908.

A production of 1,363,562 pounds of copper was credited to Fresno County in 1909 and 1910, which cannot be definitely allocated because no reports were made by the State Mining Bureau on the copper mines between 1908 and 1914. In 1915, 1916 and 1917, pillars were taken from the Copper King, resulting in a production of about 135,000 pounds of copper. In 1917, in connection with the promotion mentioned above,[21] it was claimed that the production to date had been "50,000 tons of 8% copper." This would be equivalent to the total recorded production of copper from Fresno County from 1901 to 1917 inclusive.

Macdonald [22] made a study of the areal geology of the region, and wrote as follows after examining material from the mine dump:

> "The ore appears to have been in quartz veins and stringers cutting plagioclase amphibolite and associated mica schists. Pyrite is the most abundant sulfide mineral followed by chalcopyrite. A small amount of sphalerite is present in some specimens. An interesting variety of ore is made up of roughly rounded grains of pyrite, from about 1 to 7 millimeters in diameter, embedded in a matrix of chalcopyrite. It seems probable that partial replacement of the pyrite by chalcopyrite brought about the rounding and isolation of pyrite grains in a fractured mass of earlier pyrite."

Fresno copper mine is in the SW$\frac{1}{4}$ sec. 10, T. 12 S., R. 21 E., 6$\frac{1}{2}$ miles northeast of Clovis. Three lode claims containing 40.32 acres, named Heiskell, McKinley and McKinley Extensions were patented in February, 1903 by Henry B. Vercoe. The mine had been prospected by several shafts prior to 1902, and shortly thereafter the mine became the basis of a stock company called Fresno Copper Company, Limited, Glasgow, Scotland. This company spent a large sum of money on the property, sinking the main shaft to 530 feet and building a smelter. According to a report published in 1908,[23]

> "Drifts on the 200- and 300-foot levels expose a solid body of sulphide ore, principally pyrrhotite, extending 400 feet along the course of the vein, attaining a width of 50 feet in places (averaging 14 feet in thickness), and of unknown extent downwards. This ore was supposed to average at least 7 percent copper and to contain appreciable gold, but when it was sampled after the smelter had been completed and was ready to be started, the astonishing fact became known that it assayed less than 2 percent copper and practically no gold. On the 300-foot level, a cross vein, 2 to 4 feet wide, carrying galena, iron pyrites, zincblende and silver, was discovered and followed a short distance by a drift. Small streaks of chalcopyrite appeared in the lower workings."

When the news of the low grade of the ore reached Glasgow in 1906, the price of shares in the company collapsed. F. J. Siebert, who was employed to sample the mine, reported the average copper content of the ore was 1.33 percent. Shortly thereafter, J. S. MacArthur was employed to make a report on the mine and in the course of the work he and his assistants took 600 samples. In his report, he stated that the body of pyrrhotite then exposed in the workings averaged 1.26 percent copper. This mine has been idle since 1910 and the smelter was junked about 1920. Details of production are lacking. Macdonald,[24] after examining material on the dump, stated that the amphibolites in the vicinity of the ore bodies are very coarse-grained—much coarser than anywhere else within the area mapped. Long, euhedral needles of hornblende of the amphibolite penetrate the sulfides. Macdonald expressed the opinion that such foothill copper ores belong to an earlier period of mineralization than do the gold ores of adjoining parts of the Sierra Nevada.

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[21] Copper King Mining Company: The mines handbook, vol. xiii, pp. 583-584, 1917.

[22] Macdonald, A., Geology of the western Sierra Nevada between the Kings and San Joaquin Rivers, California: Univ. of California, Dept. Geol. Sci., Bull., vol. 26, no. 2, pp. 215-286, 1941.

[23] Copper resources of California: California Min. Bur. Bull. 50, pp. 279-281, 1908.

[24] Op. cit., pp. 215-286.

Other mines, reported to have made some production of copper many years ago, but not active in recent years are:

Nieper mine, in sec. 34, T. 11 S., R. 23 E., was worked to a depth of 60 feet prior to 1890 and had produced shipping ore characterized by crystalline chalcopyrite and considerable gold.[25]

Painter mine, in sec. 33, T. 11 S., R. 21 E., 2 miles northwest of the Fresno Copper Mine, was first worked in the 1860's and reopened in 1900. Workings include three shafts and some drifts. The deepest shaft, 110 feet deep, followed oxidized ore to 100 feet in depth and then entered sulfide.[26]

Post Oak mine is in sec. 29, T. 12 S., R. 25 E. It is primarily a gold mine but the ore contained considerable copper.

Uncle Sam group of claims is in secs. 2, 3, T. 12 S., R. 29 E. Some rich ore was taken out of these claims in 1915. They are in rough country, at an elevation of 5500 feet.[27]

Other copper prospects have been listed in Division of Mines Bulletin 50.[28]

Diatomite

Insulator property, in sec. 8, T. 15 S., R. 12 E., is 1 mile north of Panoche Pass road and about 22 miles by road southwest of Mendota. Surface exposures indicate a large deposit. From 1929 to 1935 Mineral Products Manufacturing Company, Incorporated, Fresno, operated the property. A hammer mill and two cyclone separators were used to prepare the diatomite.[29] In 1935, A. P. Shepard operated the property, selling the diatomite for use in insulation and for admixture in concrete. No shipments have been reported since 1935, and the company ceased to exist in 1942.

Feldspar

Childers feldspar deposit is in sec. 23, T. 9 S., R. 22 E., 4 miles northwest of Auberry and at 3000 feet elevation.[30] This deposit was opened first by W. H. Childers of Auberry about 1930. There are eight 20-acre claims covering a series of parallel pegmatite dikes in granite. Massive outcrops of orthoclase and quartz from 10 to 50 feet wide were found. Work was done by open cuts.

Industrial Minerals and Chemical Company worked the deposit from 1936 to 1939 inclusive. In 1940, W. H. Childers, the owner, took over and operated it through 1944, since which date it has been idle.

Feldspar prospects have also been reported on the Harrison Stock Farm, Clovis, but so far as known this has not been worked commercially. Many years ago feldspar claims were located in sec. 34, T. 11 S., R. 25 E., 5 miles northeast of Trimmer and about 15 miles from the railroad at Piedra. Some work was done but no shipments have been reported.

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[25] Goldstone, L. P., Fresno County: California Min. Bur. Rept. 10, p. 194, 1890.

[26] Copper resources of California: California Min. Bur. Bull. 50, pp. 278-279, 1908.

[27] Bradley, Walter W., Fresno County: California Min. Bur. Rept. 14, p. 438, 1916.

[28] Copper resources of California: California Min. Bur. Bull. 50, pp. 224-233, 1908.

[29] Laizure, C. McK, San Francisco field division—Fresno County: California Min. Bur. Rept. 25, p. 309, 1929.

[30] Tucker, W. B., and Sampson, R. J., Feldspar, silica, andalusite and cyanite deposits of California: California Div. Mines Rept. 27, p. 415, 1931.

Gold

Most of the gold quartz mines in Fresno County described in reports published prior to 1893, were lost to the county when Madera County was created in that year. In the period since the last report in 1929, production has been principally if not entirely from placer mining and as a byproduct of the sand and gravel business. The San Joaquin River between Friant and Herndon has been the principal source. The use of suction dredges in the county has been hampered by local regulations, and proposed work of this kind was being delayed at the time of the last visit in February 1950.

Bent Company and Griffith Company shared the contract to furnish labor and equipment for building Friant Dam, with the government supplying all materials actually used in the dam. An aggregate-processing plant was placed on a deposit owned by the government and located on the San Joaquin River 2½ miles downstream from the damsite. In the course of preparing 4,457,320 tons of sand and gravel for use in the dam a total of $196,977 worth of gold and 849 ounces of silver were recovered. The profit from this was divided equally between the contractors and the U. S. government. The work was done between 1940 and 1942 inclusive, and the production of nearly $175,000 in 1941 accounts for most of the gold credited to Fresno County for that year.

Anderson Rock Company, P. O. Box 1372, Fresno, installed equipment for saving gold at their rock, sand and gravel plant at the former site of old Lanes Bridge on San Joaquin River during April, 1949.

Grant-Service Rock Company, which operated a large rock, sand and gravel plant at Rockfield, was consolidated with Pacific Coast Aggregates July 1, 1938 as Grant-Pacific Rock Company, under which name work was continued until recently. The plant is now operated by Pacific Coast Aggregates, Incorporated. For many years this plant has been equipped with riffles for saving gold. In 1937 Grant-Service Rock Company was the largest gold producer in the county, having an output of 176 fine ounces.

Between 1938 and 1946 Grant-Pacific Rock Company operated the large aggregate plant described elsewhere in this report under Pacific Coast Aggregates, Incorporated. (See under Stone). Gold saved by running the sand over Hungarian riffles was 36 fine ounces in 1943 and 155 fine ounces in 1944. The 1944 production recovered from 189,458 tons of sand and gravel indicates a recovery of 2.86 cents a ton.

Herndon Rock Products (Stewart and Nuss, Incorporated, Fresno) were preparing to install gold-saving equipment in February 1950 at their No. 1 plant at Herndon.

Hopkins-Becker Dredging Company was incorporated in 1937 by H. H. Hopkins and Gus E. Becker, inventors of the Hopkins-Becker single-bucket dredge. The first of these dredges was used on the San Joaquin River near Friant. A 9-cubic-feet-capacity bucket was rigidly mounted on a telescope boom. Digging was carried on by retracting the boom and dropping the bucket, then pulling forward to load and upward to dump. The boom served as a sluice to deliver gravel to the trommel. The outfit was mounted on a barge 30 feet long and 15 feet wide. Power was furnished by two 4-cylinder Star engines. A 9-foot trommel, 4-inch centrifugal pump, and 48 square feet of Hungarian riffles were provided for screening gravel and saving gold, and there was a belt conveyor to stack tailing. Yuba Manufacturing Company later acquired rights to make and sell the dredge. This dredge should not be confused with the Becker-type suction dredge described in a recent report on Madera County[31] as being in use currently (February 1950) on the Madera County side of San Joaquin River. The production of 298 fine ounces of gold from 121,000 cubic yards of gravel from San Joaquin River near Friant, credited to Fresno County in 1941, was made by the Becker-type suction dredge.

Granite

Superior-Academy Granite Company is a consolidation of two companies that were formerly in the business of quarrying, dressing and polishing "Academy granite." Steven Partini is president and John Andreis, secretary, Box 68, Clovis. C. S. Estill is quarry superintendent. Academy Granite Company, now part of the consolidation, began work in 1903.

Nine quarries in all have been worked on 100 acres owned by the company in the foothills 1 mile northeast of Academy, in sec. 13, T. 12 S., R. 22 E., at an elevation of 700 to 800 feet. The stone is a dark hornblende diorite, commercially called "black granite." It is of medium grain, weighing 185 pounds per cubic foot, and there is a good contrast between the dark gray dressed stone and the black polished surface. It has been used principally for monuments. Only three men were working at the quarry in May 1949. Two small air compressors supply air for drills used to break out rough blocks of stone which are trucked 11 miles to the dressing and polishing plant at Clovis on the railroad. From 10 to 12 men, including the company owners, were working at the Clovis plant in 1949. A gangsaw driven by a 50-horsepower motor is used for sawing large blocks of stone. A 15-by-12-inch two-stage air compressor and a 9-by-12-inch compressor furnish air for stone-dressing tools.

Gypsum

The gypsum produced in Fresno County has been used for soil treatment. Under federal government encouragement, this use has expanded enormously in recent years, especially in the San Joaquin valley. Gypsum in Fresno County is generally the impure form called gypsite, which occurs in the western part of the county in the Coast Range and foothills. There has been some production annually since 1930 except during the war years 1942-45. In California, the use of gypsum as an agricultural mineral reached a peak of 490,268 tons in 1947, dropping to 394,979 tons in 1948. Gypsum is believed to be useful especially for its sulfur content, and in clayey alkaline soils the calcium is also believed to be beneficial in promoting flocculation, by breaking up large, hard lumps of soil.

Although the sale of agricultural minerals in California is licensed and regulated by the State Department of Agriculture, no standards of mineral content are established. Sellers generally guarantee minimum percentages of certain ingredients, and also screen sizes of material. Frequent analyses are made by the State to determine whether or not such guarantees are being fulfilled. Gypsum sold for agricultural use here carries "guaranteed" percentages ranging from 30 to 100 percent

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[31] Logan, C. A., Mines and mineral resources of Madera County, California: California Jour. Mines and Geol., vol. 46, no. 4, p. 455, 1950.

$CaSO_42H_2O$. The actual amounts of combined sulfur found by analysis of gypsum samples taken by the Department of Agriculture from lots offered by some dealers were materially below the guaranteed 13 percent.[32]

Current practice in the San Joaquin Valley is to apply 1 to 20 tons of gypsite per acre, turning it under by shallow cultivation. Most of the gypsite is applied during the winter months when trucks are available to haul from the mines. Most of the cost of the gypsite delivered to the farm is transportation. At the mine, gypsum sells for about $1.75 per ton; delivered to the farm, it commonly costs $6 per ton. Although the better grades of gypsite (60 to 70 percent gypsum) are more expensive than lower grades, they are preferred because of the smaller transportation costs for hauling a given amount of gypsum.

Through the Federal Production and Marketing Administrations certain payments are made to farmers as an incentive to improve their soil by applying gypsite. These payments amount to 60 percent of the cost of the gypsite, exclusive of transportation and spreading costs. Maximum payment for gypsite is two cents per pound of contained sulfur. Usually, the farmer pays 50 to 60 percent of the total cost of this soil-treatment program for his farm. Federal payments are made for gypsite applied to correct alkali-soil conditions on farms, where determined necessary by the County Committees; or in connection with a full new seeding of legumes, perennial grasses, green manure crops in orchards, permanent pastures seeded alone or with a nurse crop, and winter legumes.[33] During 1948 the Federal aid program assisted in the application of 3,200 tons of gypsum (18% sulfur equivalent) to 5,755 acres on 143 farms in Fresno County.

One gypsite producer operated during 1947, four during 1948, and two during 1949.

The Bahr deposit is near the mouth of Tumey Gulch in sec. 1, T. 16 S., R. 12 E., 18 miles southwest of Mendota. It adjoins the Griffin deposit on the east. No activity at this deposit has been reported since 1948. Gypsite beds as much as 3 feet thick occur on the flanks of spurs projecting northward into San Joaquin Valley. Considerable sand and gravel impurities are included in the gypsite. This deposit is at a lower elevation than the nearby Griffin deposit.

The Griffin deposits, formerly known as the Paoli deposits are in sec. 1, T. 16 S., R. 12 E., and sec. 6, T. 16 S., R. 13 E., west of the Bahr deposit near the mouth of Tumey Gulch, 18 miles southwest of Mendota. The property was operated by A. P. Shepard of Fresno from 1930 to 1940. Gypsite is sporadically exposed on the flanks of spurs bordering Tumey Gulch. In most places the thickness of the deposits does not exceed 4 feet; however, some approach 8 feet in places. The gypsite lies on a 3-foot bed of poorly consolidated sandstone, which in turn lies upon a fossiliferous sandstone bedrock. Overlying the gypsite, above a sharp contact, is loose sand. Downward the gypsite becomes mixed with underlying sand.

Carryall scrapers were used to mine the gypsite. A hammer mill on the property was used to make a ground product. The property is idle at present; no output has been made since early 1949.

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[32] Fertilizing materials: California Dept. of Agriculture, Special Pub. No. 231, pp. 165-169, 1948.

[33] Rollins, Robert Z., Agricultural gypsum: unpublished manuscript, 1949.

Little Panoche Placer (Panoche Valley deposit) is in sec. 1, T. 14 S., R. 10 E., 3 miles northeast of Mercey Hot Springs and 1½ miles east of the highway. Agricultural Mineral and Fertilizer Company, A. D. Sousa, manager, Box 832, Los Banos, is the operator. A small hillside deposit of gypsite, 2 to 3 feet thick, is being mined by dragline scraper. Gypsite mined here is guaranteed to contain 70 percent gypsum.

Panoche No. 1 and No. 2 gypsum claims in W½ sec. 30, T. 14 S., R. 12 E., are probably the same formerly worked by Paul Schuck.

Valley View gypsum mine is in sec. 19, T. 14 S., R. 12 E., on the east flank of the Panoche Hills, 9 miles east of Mercey Hot Springs. It was operated prior to 1941 [34] and again from 1933 to 1940. The present operator, R. P. Jones, Madera, began work early in 1948. The gypsite deposits are small and contain sand and gravel. Maximum thickness is 3 feet. The product is guaranteed to contain 50 percent gypsum. Mining is done with carryalls. A shaker screen at the loading chute removes the plus ¾-inch stones.

Two other deposits were worked years ago; one in sec. 26, T. 20 S., R. 14 E., and another 9 miles north of Coalinga.

Limestone

A recent publication describes the limestone deposits of Fresno County.[35] Limestone occurs in a variety of forms in this county and is widely distributed. Marl deposits have been found in the younger formations both on the east side of the San Joaquin Valley and on the Coast Range side. Hard limestone and marble deposits are quite numerous in the Sierra Nevada. South and southeast of Fresno much of the valley land is underlain at a depth of 3 feet or more by ''white hardpan'' in which the cementing material is calcium carbonate and magnesium carbonate. These carbonates were derived from the soil above. Marl occurs in the Mount Campbell district, and the adobe soil over an area of several thousand acres surrounding Mount Campbell is mostly underlain by a light-colored marly material which is generally 6 feet or more below the surface, but in places is found at a depth of only 1 foot. Much of this marl has been mined, processed and sold.

Marl is used by farmers as a soil amendment. Within the federal soil conservation program payments are made to farmers through the Federal Production and Marketing Administration for improving their soil by adding marl. Eligible farmers are designated by county agricultural committees. Payments amount to 60 percent of the cost of the marl, not to exceed $6.50 per ton of contained calcium carbonate. Transportation and spreading expenses are paid by the farmer.

Many metamorphosed limestone deposits occur in Fresno County in the Sierra foothills. These deposits are not all listed herein as most of them are too small, too far from railroads, or too impure to be valuable as sources of limestone. Most of the limestone in this part of the Sierra Nevada has been metamorphosed to marble and is in roof pendants, which are remnants of much larger areas of pre-Cretaceous altered sedimentary rocks. The largest area of such rocks extends from Friant on San Joaquin river, east and southeast to Dunlap, a distance of about 36 miles. Limestone is associated with practically all tungsten deposits in Fresno County.

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[34] Bradley, W. W., et al, Fresno County: California Min. Bur. Rept. 14, p. 452, 1916.

[35] Logan, C. A., Limestone in California: California Jour. Mines and Geology, vol. 43, pp. 233-236, 1947.

Accordingly, locations given herein for tungsten properties also indicate limestone. Only one deposit in the Sierras, the Red Bud, is being worked for limestone.

In early days some lime was produced in the county, as evidenced by the record of shipment of $20,000 worth from Fresno in 1880. The source from which it came was not given, but it was probably from deposits near Dunlap and Alcalde, where kilns were still in operation in the late 1880's. In the period 1931-39, marl was produced from deposits near Reedley and Minkler. During 1947, the production of crushed limestone for poultry grist, stock feed, and foundry use was begun at a deposit a few miles north of Watts Valley. Marl is now being produced in the Panoche Hills along the western boundary of the county.

Coral Reef Lime Products Company produced marl for 6 years, 1931-36 inclusive, from a deposit in the Minkler district 25 miles east of Fresno, sec. 11, T. 11 S., R. 23 E., near the Squaw Valley road and close to the Atchison, Topeka & Santa Fe Railway branch line. C. M. Secrest, principal owner of the land on which the deposit was found, claimed that 125 acres was underlain by marl 4 or more feet thick. The marl was reached by stripping the soil overburden, which was 6 inches to 3 feet in thickness. The upper part of the marl was then broken with a plow and mined with a scraper drawn by a tractor which delivered it to a grizzly over a truck loading bin. When a ground product was desired the marl was dumped on a belt conveyor and passed to a grinding mill. A belt conveyor moved the ground limestone to a storage and loading bin. The mill capacity was 100 tons daily, the finished product passing a 40-mesh screen. Ten men were employed. Material produced here contained about 45 percent $CaCO_3$ equivalent.

Drake Lime Company produced marl near Minkler in 1932, 1934, and 1936. H. E. Drake was manager. Marl produced here contained $CaCO_3$ equivalent in the range 35-59 percent.

In the 1880's, a good grade of lime was made near Dunlap from limestone obtained in the northern part of T. 14 S., R. 26 E. Two deposits supported three lime kilns which used oak wood, cut nearby, for fuel.[36] Two of the kilns had a daily capacity of 100 barrels of lime each. The distance from railroad (more than 20 miles) probably caused cessation of work. The limestone is pre-Cretaceous, interbedded with slate and mica schist in roof pendants in granitic rocks.

Ellison Brothers marble claims on Big Creek near the San Joaquin marble deposits have not been developed.

Kings River deposits are 25 miles northeast of Piedra in T. 12 S., R. 26, 27 E., on the north side of Kings River. Large limestone deposits have been known there for over 50 years.

Marlife Company, 814 Olive Avenue, Fresno, operates, under a license held by Carl N. Secrest, a marl deposit on a group of 15 placer locations in the Panoche Hills, 4½ miles by road nearly east of Mercey Hot Springs. These claims were located in August and December, 1946 by A. R. Burkhart and Otis Teaford, and are at an elevation of 2100 feet, probably in sec. 18, T. 14 S., R. 11 E., in what is locally called Panoche Pass. The area covered is "approximately 400 acres". Marl occurs under 3 feet of overburden on a nearly flat-ridge summit trending northwest. A caterpillar tractor and carryall are used to dig marl and deliver it to a bin from which it is taken by belt conveyor to a hammer mill. Another belt conveyor receives the crushed marl and delivers it to trucks which haul loads of 16 to 21 tons to purchasers. The marl is naturally pulverulent and requires little crushing for agricultural use. It is stated to contain 50 to 60 percent $CaCO_3$. Most of the product is sold in the area near Fresno, 62 miles by road from the deposit.

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[36] Irelan, William Jr., Fresno County: California Min. Bur. Rept. 8, p. 208, 1888.

Montford Marl deposit is on 40 acres in sec. 24, T. 21 S., R. 14 E., about a mile from Alcalde and 2 miles from LeRoy on the railroad. In the 1880's lime was made from a ''vein'' of limestone 12 feet wide which extends across 40 acres. This limestone contains a small amount of bituminous matter.

Mount Campbell Lime Company, Dinuba, produced marl from near Reedley in the period 1937-39. The marl here contains above 47 percent $CaCO_3$ equivalent.

Red Bud limestone deposit is on the Spencer ranch in sec. 15, T. 11 S., R. 24 E., 4½ miles southeast of Tollhouse and 40 miles by road from Fresno. Al Feuerstein, 3863 Kerckhoff Avenue, Fresno, lessee. An open cut has been started on a small deposit of white limestone of good grade. Stone is quarried and broken by hand and sent by tramway 600 feet long to the mill. Here it is broken in two Cedar Rapids crushers to sizes ranging from 1½ inches downward; finer sizes are ground in a rod mill and are separated by screening. The milled products are sold for poultry and chick grits, mixed feeds and soil treatment. An automobile motor is used for power. Feuerstein, working alone when visited October 18, 1948, hauls the limestone to Fresno by truck.

The following analysis has been furnished by the lessee:

	Percent
$CaCO_3$	97.68
$MgCO_3$	1.37
SiO_2	0.55
Fe and Al oxides	0.35

At Sampson's Flat, north of Dunlap on the south side of Kings River, a heavy ledge of blue limestone is reported, but so far as known has not been developed.

San Joaquin marble deposit is in sec. 36, T. 8 S., R. 24 E., on Big Creek. The San Joaquin & Eastern Railroad crosses the section within a mile of the deposit and 500 feet above it, and a road connects with the Huntington Lake highway 2 miles distant. There is also an electric power house in the NW¼ sec. 36. A. Emory Wishon, et al, at one time owned 125 acres on which the deposit occurs. White, blue, and black marble of good quality is reported in a lens-shaped deposit about half a mile long lying mostly on the south side of the creek.

Twin Lakes deposit is in secs. 29 and 30, T. 7 S., R. 26 E. This is a deposit of pre-Cretaceous crystalline limestone altered to marble and containing several smaller bodies of calc-silicate hornfels. It has been studied in detail by C. W. Chesterman.[37] It is in the high Sierra Nevada, 3 miles north of the east end of Huntington Lake, at an elevation of 8,500 to 8,800 feet. As mapped, this limestone pendant is over 10,000 feet long and from 1250 to 3000 feet wide. Chesterman's article is a study of the contact-metamorphic rocks formed where the Sierra Nevada batholith intruded a region deeply covered by older sediments. The original upper portions of the sediments have been removed by the agents of erosion, including glaciation. He describes three kinds of marble, for two of which partial analyses are given.

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[37] Chesterman, Charles W., Contact metamorphic rocks of the Twin Lakes region, Fresno County, California: California Div. Mines Rept. 38, pp. 243-280, 1942.

Calcite marble is most common and varies from gray banded to statuary white and skyblue. Its specific gravity is 2.69 and the partial analysis was as follows:

	Percent
CaO	47.42
MgO	5.92
Insoluble	1.20

The partial analysis of the dolomitic marble, usually white, was as follows:

	Percent
CaO	33.54
MgO	27.83
Insoluble	1.43

Some nearly pure dolomite was mentioned as occurring with this.

Brucite marble, ''characterized by the occurrence of small globular or spheroidal masses of brucite ($MgO.\ H_2O$)'' occurs in limited quantity. Chesterman explains its occurrence as due to the hydration of periclase marble which he thinks was formed in the early period of contact metamorphism.

The examination of the region in 1942 was made with particular reference to scheelite, which occurs there in small quantities. No work was done on the marble, so far as known.

Webb & Mingus calcite prospect is in sec. 12, T. 20 S., R. 13 E., 10 miles northwest of Coalinga on Sherman Peak. No production has been reported.

Magnesite

Deposits of magnesite have been worked in the vicinity of Piedra on both sides of Kings River. The magnesite occurs as veins and anastamosing veinlets from a few inches to 4 feet in width, in serpentine, of which a body several miles wide extends northward 11 miles from Piedra. Most of the magnesite mined has come from this area. Several other bodies of serpentine are known in the county, however, both in the Coast Range and on the east side of the Central Valley, and magnesite has been found in some of these.

Nearly 22,000 tons of magnesite was produced in Fresno County between 1909 and 1921. In recent years, the mining of deposits of magnesite has practically ceased in California. It has been found that better control over composition of magnesia and other magnesium products can be achieved by making them from the bittern remaining at salt plants after removing common salt, or by precipitating them from raw sea water, than by processing mined ores. Magnesium metal has also been produced on a large scale from magnesium compounds derived from sea water. No production of magnesite has been recorded in Fresno County since 1924. Bradley[38] described several of the mines near Piedra.

The following are the names of mines or prospects for which definite locations are available:

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[38] Bradley, Walter W., Magnesite in California: California Min. Bur. Bull. 79, pp. 44-46, 1925.

Fresno (Bachler and Piedra Magnesite Company), Magnesite mine in sec. 5, T. 13 S., R. 24 E. This was the principal producer of magnesite in the county.

Piedra (Ward) mine in sec. 9, T. 13 S., R. 24 E. was a producer.

Sample Mine (Ferguson), on Holland Creek south of Academy, produced "many carloads" of siliceous magnesite, analyzing as low as 0.4 percent CaO.

Webb and Mingus deposit is on the headwaters of White Creek in secs. 3, 4 and 5, T. 19 S., R. 13 E., (approx.) at an elevation of about 3000 feet. So far as known, it is undeveloped.

Manganese

The following is taken from a recent bulletin:[39]

> "Manganese is reported from eight places in Fresno County. Six lie in a northwest-trending belt that crosses the Kings River about 5 miles northeast of Piedra, in the east-central part of the county. These deposits are essentially in the projection of the strike of the deposits in Madera County to the north. They consist of segregation of rhodonite in recrystallized chert of quartzite interbedded with schist of the Calaveras type. One, the Harper deposit, contains spessartite. Two deposits are in Franciscan rocks in the Coast Ranges, at the southwestern edge of the county. One of these, the Sunset and Sunrise mine, is the only one that has produced manganese in the county."

Geologic descriptions of the deposits mentioned above are contained in a Division of Mines bulletin.[40]

The manganese deposits are included in the tabulation of mines and are also shown on the map accompanying the present report.

Mercury (Quicksilver)

Archer mercury mine comprises 7 unpatented claims in the NW¼ sec. 2 and NE¼ sec. 3, T. 19 S., R. 13 E., at elevations of 3500 to 4000 feet. Ben J. Byles, Box 667, Coalinga, is the owner. Archer Mining Company, R. D. Prior, manager, 510 South Spring St., Los Angeles, has had the property under lease and option to purchase for 6 years. The mine is about 30 miles by road north of Coalinga, of which the last 6 miles are a steep private road subject to snowfall in winter.

The deposit was found in 1904 by the late Joseph Byles and was worked by him and his sons until about 1940 and then steadily for 2 or 3 years. They made several open cuts and drove the upper adit 500 feet, crossing several ore bodies in shear zones, from which they took ore by drifting and stoping. The footwall is serpentine, and according to Ben Byles, ore occurred in "hard blue rock" (Panoche shale, Cretaceous), and carried considerable iron sulfide. Eight retorts were operated, each handled 500 lbs. of ore at a charge. Ore was hand sorted, crushed to about 1 inch, and retorted for 12 hours. Mr. Byles thinks this selected ore averaged about 1½ percent mercury.

The mine workings are in the Panoche (Cretaceous) shale at a fault contact along the southeast end of a body of serpentine extending from San Benito County into western Fresno County. The adit workings parallel the fault line which strikes northeastward, and six shear zones carrying ore strike nearly south and were crossed by the adit. Besides the drifting and stoping on these shear zones, Byles and sons sank a winze 115 feet below the adit level, and shallower winzes in ore.

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[39] Jenkins, O. P., and others, Manganese in California: California Div. Mines Bull. 125, p. 77, 1943.

[40] Trask, P. D., and others, Geologic description of the manganese deposits of California: California Div. Mines Bull. 152, 1950.

Since the last report,[41] the Archer Mining Company has driven a new adit 1600 feet long, 220 feet below the Byles adit. For 2 or 3 months in 1948 ore was hauled to the New Idria mine for furnace treatment. The results were encouraging enough to induce the company to move in a rotary furnace, but on account of wet weather and steep grades near the mine, this furnace was still some distance from the mine in April, 1949.

Anita mine, formerly called the Rita or Santa Reta, is near the line common to secs. 17 & 18. T. 18 S., R. 13 E., probably in SW¼ sec. 17. Some production has been made from ore taken from Panoche (Cretaceous) sandstone near the eastern border of the large body of serpentine with which the mercury mines of the region are associated. The last production, from shallow workings, was made in 1942 by Anita Mining Company, 3025 Fletcher Drive, Los Angeles.

Arambide mine is one of the claims of the old Mercey mine in the NE¼ sec. 5, T. 14 S., R. 10 E., described in a past report.[42] In 1942, General Dredging Company, Natoma, produced some mercury from this mine.

Del Mexico mine (Mexican) is in SW¼ sec. 22 and NW¼ sec. 27, T. 18 S., R. 13 E., in Cretaceous sandstone close to the east end of the extensive serpentine body extending eastward from San Benito County. The elevation is 3700 feet. This old mine has been worked off and on since 1860. The last production was made in 1936.

Koski group of mercury claims include the Yucina, Cedar Springs, Joaquin and El Venado, 25 miles northwest of Coalinga by road. The Joaquin claim on which most work has been done, is in sec. 34, T. 18 S., R. 13 E. J. M. Koski, Route 1, box 3, Brush Prairie, Washington, is the owner.

On the Cedar Springs claim is an air compressor and an adit has been started from an open cut 70 feet long by 6 feet wide. A small orebody, from a seam to 8 inches wide, has been traced for 14 feet. On the Joaquin claim is an old adit 100 feet long showing a small prospect at the face. This claim also has an open cut 70 feet long by 8 feet wide and 20 feet high at the face, with an incline of 18 feet. There are 2 retorts on this claim and some ore has been roasted which yielded 0.5 percent mercury, but no mercury has been sold. Only assessment work has been done recently.

Mica

Ruth Hill mica prospect is near the east line of sec. 12, T. 14 S., R. 25 E., ¼ mile from the old Dunlap-Squaw Valley road at an elevation of 2400 feet. Some muscovite mica in books up to 4 inches square was produced 30 years ago. No work has been done recently.

An open cut 50 feet long by 10 feet wide and a maximum of 10 feet deep was run N. 80° W. and a small shaft of unknown but probably shallow depth was sunk. Muscovite occurs in a pegmatite composed largely of quartz and feldspar with small amounts of garnet and hornblende. No mica over 1½ inches in diameter remains. The work has exposed a width of 58 inches of pegmatite in which mica occurs in bunches and clusters. There are no other outcrops nearby. Ownership was not learned.

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[41] Eckel, Edwin B., and Myers, W. B., Quicksilver deposits of the New Idria district, San Benito and Fresno Counties, California: California Div. Mines Rept. 42, pp. 81-124, 1946.

[42] Bradley, Walter W., Quicksilver resources of California: California Min. Bur. Bull. 78, pp. 44-45, 1918.

Mineral Water

Although the county contains numerous mineral springs, not many have been utilized commercially. In late years, few persons spend vacations at mineral spring resorts as was once the custom. Some of the mineral springs in Fresno County yield water popularly believed to have medicinal value, and these springs have been used for bathing. Three, Coalinga Mineral Springs (also called Fresno Hot Springs), Collins or Millerton Spring and Mercey Hot Springs have had hotel accommodations. At late as 1939, some bottled water was sold from Mercey Hot Springs, but no sales have been recorded since.

The mineral springs have been described by G. A. Waring [43] and by C. McK Laizure.[44]

Coalinga Mineral Springs are in the SE¼ of sec. 34, T. 20 S., R. 13 E., at an elevation of 2100 feet. They are reached from State Highway 198 by turning north at a point 13 miles west of Coalinga and traveling over 5 miles of good oiled road which follows the course of Hot Springs Canyon. This resort was probably the best known of its kind in Fresno County and the water has been used for about 70 years. In early days, the springs were known as Fresno Hot Springs. There are 15 different springs or seepages supplying water from the hillside above the hotel. Most of these springs are cemented in and at present the water being used at the resort is supplied by six springs. The resort is operated by Coalinga Mineral Springs, Inc., P. O. Box 307, Coalinga. Robert Lee Abell is the manager. A modern bath house is operated in connection with the hotel.

Mercey Hot Springs is in SE¼SE¼, sec. 15, T. 14 N., R. 10 E., about 35 miles by road west of Mendota within half a mile of the San Benito County line, at an elevation of 1150 feet. The springs, small hotel and other buildings are leased to Crooks and Ustick, Box 337, Dos Palos. H. C. Swatzel is manager.

The water of the main spring is conserved in a covered concrete reservoir and flows by gravity to a small bath-house and the hotel building. The temperature of this spring is 112° F. Another small warm sulfur spring is used only for irrigation.

The following analysis from current advertising matter is slightly different from one quoted by Waring:

Analysis	*Parts per million*
Silica	76.0
Sulfuric acid radical	5.0
Bicarbonic acid radical	None
Carbonic acid radical	27.0
Nitric acid radical	None
Phosphoric acid radical	0.41
Tetraboric acid radical	54.00
Arsenic acid radical	0.02
Chlorine	1280.0
Bromine	1.0
Iodine	2.1
Iron oxide	0.2

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[43] Waring, Gerald A., Springs of California: U. S. Geol. Survey Water-Supply Paper 338, pp. 78-79, 1915.

[44] Laizure, C. McK, San Francisco field division—Fresno County: California Div. Mines Rept. 25, pp. 319-323, 1929.

Analysis	*Parts per million*
Alumina	1.7
Mangano-manganic oxide	None
Barium	None
Strontium	None
Calcium	39.0
Magnesium	1.4
Potassium	5.6
Sodium	838.36
Lithium	Trace
Ammonium	4.6
Oxygen	8.5
	2344.89

Mother Green's Ball Mountain Mineral Spring is near Coalinga, in sec. 24, T. 20 S., R. 12 E. Plans were being made in 1948 to bottle the water for sale. The following analysis was made in June 1948 by The Twining Laboratories, Fresno:

Analysis	*Parts per million*	*Grains per gallon*
pH=8.0		
Carbonates (CO_3)	Nil	Nil
Bicarbonates (HCO_3)	445.3	25.97
Chlorides (Cl)	39.0	2.27
Sulphates (SO_4)	802.9	46.82
Nitrates (NO_3)	5.0	0.29
Borates (B_4O_7)	0.8	0.05
Phosphates (P_2O_5)	0.2	0.01
Calcium (Ca)	63.4	3.70
Magnesium (Mg)	71.1	4.15
Sodium (Na)	367.8	21.45
Potassium (K)	6.7	.39
Strontium (Sr)	1.5	.09
Silicon (Si)	17.8	1.04
Iron (Fe)	0.2	0.01
Aluminum (Al)	Trace	Trace
Manganese (Mn)	0.2	0.01
Copper (Cu)	0.02	Trace
Lithium (Li)	0.01	Trace
Iodine (I)	0.30	0.02
Arsenic (As)	None	None
Total solids	1827.0	106.55
Total hardness (as $CaCO_3$)	454.6	26.51
Hypothetical Combinations		
Calcium bicarbonate ($Ca(HCO_3)_2$)	256.8	14.98
Magnesium bicarbonate ($Mg(HCO_3)_2$)	303.0	17.67
Magnesium sulphate ($MgSO_4$)	102.7	5.99
Strontium sulphate ($SrSO_4$)	3.1	0.18
Sodium tetraborate ($Na_2B_4O_7$)	2.5	0.15
Sodium Nitrate ($NaNO_3$)	6.8	0.40
Sodium phosphate (Na_3PO_4)	0.4	0.02
Sodium sulphate (Na_2SO_4)	1064.0	62.05
Manganese sulphate ($MnSO_4$)	0.6	0.03
Lithium sulphate (Li_2SO_4)	0.1	0.005
Copper sulphate ($CuSO_4$)	0.1	0.005
Sodium chloride ($NaCl$)	35.7	2.08
Potassium chloride (KCl)	12.7	0.74
Potassium iodide (KI)	0.4	0.023
Silicon oxide (SiO_2)	38.0	2.22
Iron sulphate ($FeSO_4$)	0.5	0.03

Petroleum and Natural Gas

Introduction [45]

The oil and gas fields in Fresno County are confined to the foothills of the Coast Range and to the floor of the San Joaquin Valley. With two exceptions, the reservoir rocks of these fields are porous formations of the early and middle Tertiary period. It is generally believed that this gas and oil originated in highly organic Tertiary shales, such as the Kreyenhagen shale, and migrated to the present reservoir beds. It is the rule, rather than the exception, for Tertiary formations of the San Joaquin Valley to exhibit lenticularity and facies changes and not to be lithologically correlative over any great distance. Therefore, stratigraphic changes play an important part in the accumulation of oil and gas in commercial pools.

History of Oil and Gas Production in Fresno County. The Coalinga area in Fresno County was the scene of some of the earliest oil activity in the San Joaquin Valley. As early as 1887 the Coast Range Oil Company developed Miocene production in the East Coalinga field by drilling on a seep. Discovery of Oil City and the West Side field soon followed, and by 1930 the Coalinga fields were producing in excess of 2,000,000 barrels of oil annually. However, accelerated discoveries and production in the southern San Joaquin Valley and the Los Angeles basin soon far outstripped Fresno County production. In 1928 the discovery of Kettleman North Dome, the northern end of which lies within Fresno County, added to the County's reserves. By that time it had become an axiom in the oil industry that no oil would be found north of Coalinga. The discovery of Eocene production at Coalinga in 1938 and East Coalinga Extension in 1939 were the next important events affecting the oil industry in Fresno County.

Until 1941 all of the oil produced in Fresno County had come from the western edge of the valley where Tertiary rocks were exposed and geological structure was visible. It had long been suspected that undiscovered oil reserves existed out beneath the valley alluvium, but the abundance of oil in Kern County and old prejudices focused exploration elsewhere. However, in 1941 four new oil fields were discovered in Fresno County, three of which were far out in the center of the valley, north of Coalinga. These were the Raisin City, Helm, and Riverdale fields. Since 1941 developments in Fresno County have been confined to the finding of extensions and new pools in known fields and the discovery of a few small fields near previously discovered fields.

Fresno County Oil and Gas Production. In 1949 Fresno County produced approximately 42,000,000 barrels of oil and 70,000,000 thousand cubic feet of gas. This represents about 7.8 percent of the 1949 state oil production and 8.4 percent of the 1949 state gas production. Fresno is the third ranking California oil-producing county, following Los Angeles and Kern Counties. At present no oil refineries are operating in Fresno County, the Shell Oil Company skimming plant at Coalinga having closed down in 1949.[46] However, three natural gasoline and liquefied petroleum gas plants are in operation. These plants, their capacities and the fields they serve are listed in the accompanying table.

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[45] See section on geology for general geology of county.

[46] Knudsen, Edward T., Petroleum refineries, cracking plants, natural gasoline plants and cycle plants in district five: U. S. Bur. Mines, Jan. 1, 1950, mimeographed.

Discovery and production data on Fresno County oil fields

Field	Year discovered	Average producing depth	Producing beds	Number of producing wells in 1949*	Proven acres*	Gravity A. P. I.	1949 production barrels oil*	1949 production Mcf gas*	Cumulative production barrels oil*
Oil City***	1898	1,200	Moreno	1,138	16,854	35°-48°	7,529,045	1,078,120	439,031,794
Coalinga Eastside***	1887	2,076	Temblor			12°-25°			
Coalinga Westside***	1901	1,814	Temblor			17°-18°			
			Etchegoin						
E. Coalinga Extension	1938	8,000	Gatchell	163	4,270	28°-42°	19,353,844	30,904,658	183,281,748
Pleasant Valley	1943	9,100	Gatchell	22	430	29°	1,151,780	1,425,306	7,768,972
Guijarral Hills	1948	8,500	Leda	44	1,010	36°-38°	2,906,899	1,877,994	2,995,935
			Allison						
Jacalitos	1941	3,875	Temblor	109	2,500	32°-48°	2,293,014	3,186,063	11,467,535
Raisin City	1941	5,710	Temblor	55	1,125	24°-29°	1,363,136	687,639	7,250,492
			Eocene						
Helm	1941	7,500	Temblor	76	4,160	30°-63°	1,403,138	4,474,890	10,023,955
			Nortonville						
			Domengine						
			Truman						
			Weyant						
			Wheatville						
			Noble						
Riverdale	1941	7,900	Miocene	50	1,200	32°-39°	966,335	1,824,156	8,915,478
			Eocene						
San Joaquin Area	1947	7,025	Eocene	6	130	30°-31°	135,826	134,924	283,466
Burrel Area	1943	6,680	Temblor	6	160	25°	114,487		171,586
Cheney Ranch Area	1940	7,250	Moreno	1	10	Dist.	1,620		10,489
Kreyenhagen Area	1949			1	10		300		300
Cantua Creek Area	1940	9,350	Eocene	0	10	50°	0	0	3,649
Kettleman North Dome**	1928	9,200	M. Miocene	315	13,075	34°-51°	11,738,815	72,800,760	362,229,796
			L. Miocene						
			Eocene						

* Summary of Operations, California oil fields, California Div. Oil and Gas, pp. 27, 71, July-December, 1949.

** Includes part of Kings County.

*** In gathering statistics the Division of Oil and Gas places the Oil City, Coalinga Eastside and Coalinga Westside fields together under the classification of Coalinga field.

Fresno County Oil and Gas Reserves. The large estimated reserves of oil and gas in Fresno County adequately reflect its position as the third ranking producing county in the state. The following table shows the estimated oil and gas reserves for the principal fields in the county as of January 1, 1950. The production and reserve figures for Kettleman North Dome given in this report are for the entire field, although about 40 percent of the production comes from Kings County.

On January 1, 1950 the estimated oil and gas reserves for the entire state were 4,900,672 thousands of barrels of oil and 9,510,761,437 thousands of cubic feet of gas.

Natural gasoline and liquefied gas plants in Fresno County *

Operation	Fields	Nearest town	Daily capacity natural gasoline	Liquefied gases (gallons)
General Petroleum Corporation	Helm Riverdale Burrel	Burrel	20,000	40,000
Robert S. Lytle	Guijarral Hills	Coalinga	30,000	30,000
Standard Oil Co. of California	East Coalinga Extension	Coalinga	45,000	----------

* Knudsen, Edward T., op. cit.

Description of Individual Oil Fields

Geographically and geologically the oil fields in Fresno County may be divided into two groups: those on the western edge of the valley, and those on the valley floor. The accompanying chart lists the formations present in each of these areas.

West Side Fields. Practically all of the west side fields are in the vicinity of the town of Coalinga, and with the exception of Kettleman North Dome they may be placed together as the Coalinga group. The individual members of this group are as follows:

Oil and gas reserves of Fresno County fields

Field	Thousands of barrels of oil*	Thousands of cubic feet of gas**
Oil City	294	----------
Coalinga Eastside	75,458	----------
Coalinga Westside	29,654	----------
East Coalinga Extension	226,236	463,859,561
Pleasant Valley	12,583	15,637,236
Guijarral Hills	62,461	----------
Jacalitos	28,315	----------
Raisin City	7,419	3,799,787
Helm	12,323	190,984,024
Riverdale	10,737	24,654,502
San Joaquin	331	----------
Burrel	624	----------
Kettleman North Dome	121,650	1,554,698,307
Totals	588,084	2,253,633,417

* Data from Annual Review, Petroleum World, pp. 6-7, 1950.
** Data from Summary of Operations, California Oil Fields, California Div. Oil and Gas, pp. 41-42, July-December, 1949.

Formations present in the Coalinga area

Formation	*Age*
Alluvium	Recent
Tulare	Pleistocene
San Joaquin	U. Pliocene
Etchegoin	L. Pliocene
Jacalitos	L. Pliocene
Temblor	M. Miocene
Includes Big Blue shale and Allison sands.	
Vaqueros	L. Miocene
Kreyenhagen (Wagonwheel and Markley)	Oligocene to U. Eocene
Includes Leda sand and Canoas silt.	
Domengine	M. Eocene
Arroyo Hondo	M. Eocene
Includes Gatchell sand.	
Martinez	Paleocene
Moreno and Panoche	U. Cretaceous

Formations present in the Helm area

Formation	*Age*
Alluvium	Recent
Undifferentiated	Pleistocene
Undifferentiated	Pliocene
Santa Margarita	U. Miocene
McLure	U. Miocene
Temblor	M. Miocene
Kreyenhagen	Oligocene to U. Eocene
Nortonville (at base of Kreyenhagen)	U. Eocene
Domengine	M. Eocene
Paleocene	Paleocene
Includes Truman sand and Weyant sand.	
Moreno and Panoche	U. Cretaceous
Includes Wheatville sand and Noble sand.	

Oil City Field. Development of the Oil City area started as early as 1898. Accurate records for this early period do not exist, but it has been reported that the largest well showed an initial production of 700 barrels per day of 48° gravity paraffin base oil.[47] The Oil City field is unusual in that it produces entirely from Upper Cretaceous (Moreno) sediments. The structure of this field is that of an asymmetrical anticline open on the northwest. The wells range in depth from 300 to 1,700 feet. In 1949 the Oil City field produced 28,002 barrels of 35° to 68° gravity oil from 12 pumping wells.[48]

Westside Field. The Westside Coalinga field was discovered in 1901 and is still an outstanding producer. Productive zones are principally the Temblor sands, with a minor amount of oil coming from the basal Etchegoin.[49] The structure is an eastward dipping homocline, with closure effected on the west by overlapping Pliocene sediments. In 1949 this field produced 1,896,195 barrels of 17° to 18° gravity oil from 572 pumping wells.[50]

Eastside Field. The Eastside Coalinga field was discovered in 1887 and is the principal Miocene producer in the area. It is about 1 mile to the southeast of the Oil City field along the same anticlinal trend. Closure to the northwest is probably effected by a combination of overlap and tar seal. Production is from the Temblor sands of middle Miocene age at depths averaging about 2100 feet. In 1949 this field produced 5,605,360 barrels of 12° to 25° gravity oil from 530 pumping wells.[51]

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[47] Birkhauser, Max, Coalinga Oil Field: California Div. Mines Bull. 118, pp. 484-485, 1943.

[48] Annual Review, Petroleum World, pp. 101, 131, 1950.

[49] Birkhauser, Max, op. cit.

[50] Annual Review, Petroleum World, pp. 101, 131, 1950.

East Coalinga Extension Field. The nomenclature of this field is somewhat confused, being divided by some into a Coalinga Nose and a Coalinga Northeast field. The Division of Oil and Gas has officially designated the field as the East Coalinga Extension, and subdivided it into a southern Gatchell area and a northern Amerado area.[52] The discovery well, drilled in 1933 on the Coalinga-Kettleman trend as an updip test of an Eocene sand present at the northern end of the Kettleman Hills structure, encountered a productive Eocene sand at 6813 feet. Subsequent developments have shown that this sand lens, now known as the Gatchell sand, has a maximum thickness of 800 feet and lenses out rapidly in all directions.[53] Commercial accumulations of oil in this area are found along the main Coalinga anticline, and in a subsidiary anticline to the north in the Amerado area. The accumulation, therefore, is the result of a combination of a stratigraphic and structural control. In 1949 East Coalinga Extension produced 19,383,844 barrels of 28° to 42° gravity oil and 30,904,658 thousand cubic feet of gas from 163 flowing and pumping wells.[54]

Jacalitos Oil Field. The Jacalitos oil field was discovered in 1941 by Wilshire Oil Company with an initial production of 85 barrels per day of 40° gravity oil from upper Temblor sands. In 1944 Tidewater Associated Oil Company brought in production from the lower Temblor sands.[55] The structure of this oil field is anticlinal. In 1949 the field produced 2,293,014 barrels of 32° to 48° gravity oil and 3,186,063 thousand cubic feet of gas from 109 pumping and flowing wells.[56]

Pleasant Valley Oil Field. The Pleasant Valley oil field, located a few miles southeast of East Coalinga Extension along the Coalinga-Kettleman trend, was discovered in 1943 with an initial production of 819 barrels daily of 28° gravity oil. The producing zone is the Eocene Gatchell sand. In 1949 this field produced 1,151,780 barrels of 29° gravity oil and 1,425,306 thousand cubic feet of gas from 22 flowing and gas-lift wells.[57]

Guijarral Hills Oil Field. Guijarral Hills oil field is southeast of the Pleasant Valley oil field on the same anticlinal trend. It was discovered in 1948 by Barnsdall Oil Company. Production came from the top 72 feet of the Leda sand in the uppermost Kreyenhagan. Subsequently, as much as 300 feet of saturated Leda sand was found. Study of electric logs resulted in the opening up of the Allison sands which are in the lower Temblor formation.[58] This field, which produced 2,906,-

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[51] Annual Review, Petroleum World, pp. 101, 131, 1950.

[52] Summary of operations, California oil fields: California Div. Oil and Gas, pp. 15-29, Jan.-June 1942.

[53] Chambers, L. S., Coalinga East Extension area of the Coalinga oil field: California Div. Mines Bull. 118, pp. 486-490, 1943.

[54] Summary of operations, California oil fields: California Div. Oil and Gas, pp. 27, 71, July-December 1949.

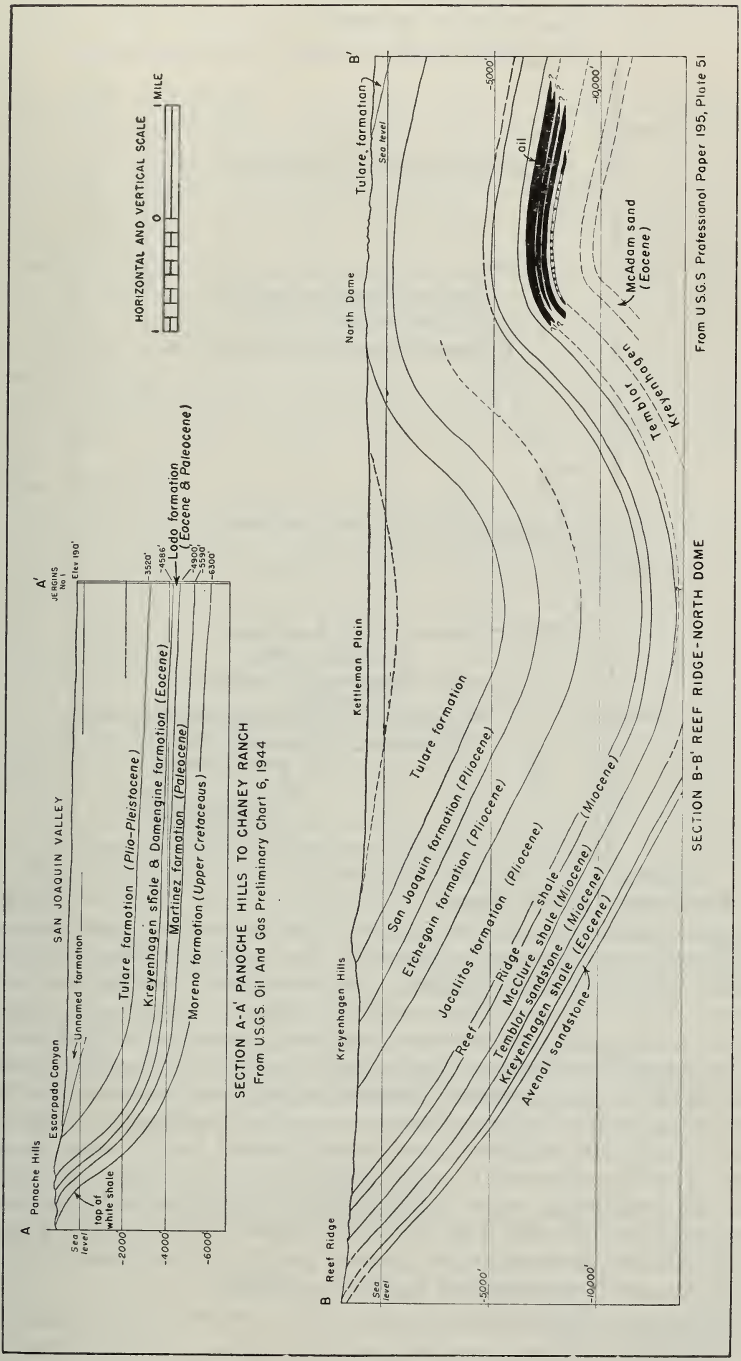
[55] Annual Review, Petroleum World, p. 210, 1949.

[56] Summary of operations, California oil fields: California Div. Oil and Gas, pp. 27, 71, July-December 1949.

[57] Summary of operations, California oil fields: California Div. Oil and Gas, pp. 27, 71, July-December 1949.

[58] Summary of operations, California oil fields: California Div. Oil and Gas, pp. 67-68, July-December 1949.

FIGURE 1


A
Panoche Hills
Escarpada Canyon
Unnamed formation
SAN JOAQUIN VALLEY
A'
JERGINS No 1
Elev 190'
Sea level
-2000
-4000
-6000
top of white shale
Tulare formation (Plio-Pleistocene)
Kreyenhagen shale & Domengine formation (Eocene)
Lodo formation (Eocene & Paleocene)
Martinez formation (Paleocene)
Moreno formation (Upper Cretaceous)
-3520'
-4586'
-4900'
-5590'
-6300'
HORIZONTAL AND VERTICAL SCALE
1
0
1 MILE
B
Reef Ridge
Kreyenhagen Hills
Kettleman Plain
North Dome
Tulare formation
B'
Sea level
-5000'
-10,000'
oil
?
McAdam sand (Eocene)
Kreyenhagen
Temblor
Tulare formation
San Joaquin formation (Pliocene)
Etchegoin formation (Pliocene)
Jacalitos formation (Pliocene)
Reef Ridge shale (Miocene)
McClure shale (Miocene)
Temblor sandstone (Miocene)
Kreyenhagen shale (Eocene)
Avenal sandstone

SECTION A-A' PANOCHE HILLS TO CHANEY RANCH
From U.S.G.S. Oil And Gas Preliminary Chart 6, 1944

SECTION B-B' REEF RIDGE-NORTH DOME
From U.S.G.S Professional Paper 195, Plate 51

899 barrels of oil and 1,877,994 thousand cubic feet of gas from 44 wells in 1949[59] has reserves in excess of the adjoining Pleasant Valley field.

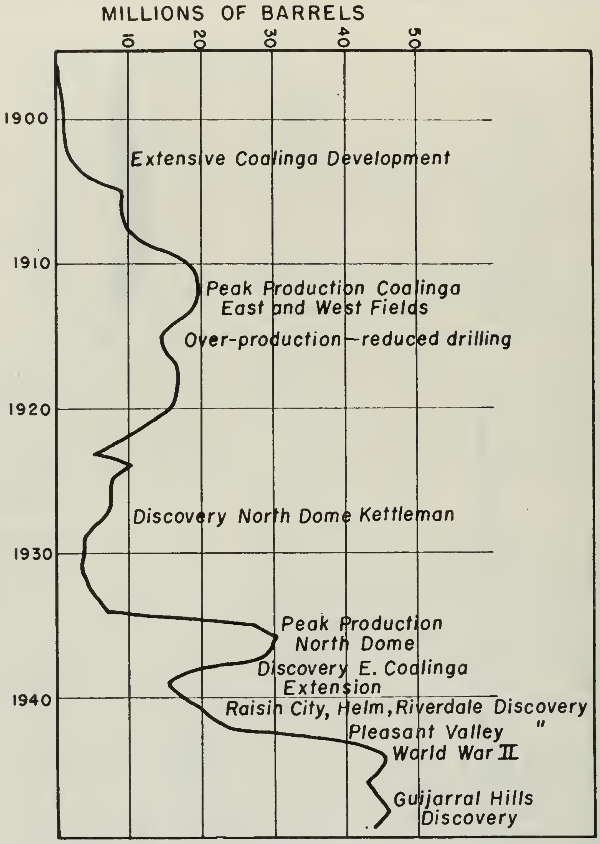


FIGURE 2. Petroleum production history, Fresno County, 1895-1949.

Kettleman North Dome. Kettleman North Dome oil field is an elongate closed dome approximately 14 miles long in a northwest-southeast direction and about 2 miles wide. The northernmost 5 miles of this field lie within Fresno County; the remaining 7 miles are in Kings County. This field was discovered in 1928 as a result of the study of surface geology. There are seven producing zones in the field, the upper five of which are Temblor sands and are the most prolific producers. Zone six is in the Vaqueros formation and zone seven is the Eocene Avenal sandstone. Surface closure can easily be mapped and amounts to 3100 feet. Studies of subsurface geology reveal that closure on the top of the Temblor amounts to only 2200 feet.[60] At the close of 1949 there were 315 producing wells in Kettleman North Dome oil field, and the production for the year was 11,738,815 barrels of 35° to 51° gravity oil and 72,800,760 thousand cubic feet of gas.[61] Approximately 60 percent of this amount was produced in Fresno County.

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[59] Summary of operations, California oil fields: California Div. Oil and Gas, pp. 27, 71, July-December 1949.

[60] Galloway, John, Kettleman Hills oil field: California Div. Mines Bull. 118, pp. 491-493, 1943.

[61] Summary of operations, California oil fields: California Div. Oil and Gas, pp. 27, 71, July-December 1949.

Valley Floor Fields. The valley oil fields of Fresno County have all been discovered subsequent to 1940, principally as the result of reflection seismograph work. 1941 was the most active year with three discoveries.

Raisin City Oil Field. The Raisin City oil field was discovered on June 2, 1941, by Shell Oil Company Properties, Inc., with a well in sec. 18, T. 15 S., R. 18 E. The original well produced dry gas from a nonmarine middle Miocene sand called Temblor, from the depth interval of 5005 to 5045 feet.[62] Subsequent development revealed several additional sand bodies saturated with 24° to 29° gravity oil. The field has been developed as an oil field. The structural control is anticlinal, and credit for the discovery is shared jointly by seismograph work and subsurface studies. On August 5, 1943, the Seaboard Oil Company developed Eocene production [63] with a deep test in section 14. The initial production was 448 barrels per day of 24° gravity oil. Production is from a thin sand zone encountered in the discovery well at 6253 feet. In 1949 this field produced 1,363,136 barrels of oil from 55 flowing and pumping wells.[64]

Helm Oil Field. The Helm field, approximately 2 miles southwest of the town of Helm, was discovered by the Amerada Petroleum Corporation in October 1941. The producing area is confined to a northwest-elongated anticline, approximately 12 miles long and 1 mile wide. The discovery well tested three productive zones in the interval 7300-8053 feet ranging in age from middle Miocene to upper Eocene. The well was completed in a thin sand lens of middle Miocene age in the interval 7300-7310 feet. The initial production from this zone was 242 barrels per day of distillate of 64° A.P.I. gravity. Subsequent development revealed other producing zones and the field now produces from the Temblor, Nortonville, Domengine, Paleocene and Upper Cretaceous formations.[65] In 1949 the Helm oil field produced 1,403,138 barrels of oil and 4,474,890 thousand cubic feet of gas from 76 wells.[66] The Lanare area which is in the southeastern part of the Helm field, was originally a separate development, but is now included within the confines of the Helm field.

Burrell Area. The Burrell area, first brought into production in 1943, is a small producing area about 2½ miles northeast of the Helm field. Production is confined to a thin lens of Temblor sands. Six wells in the area produced 114,487 barrels of oil in 1949.[67]

Riverdale Oil Field. The Riverdale oil field, discovered in 1941, is about 6 miles east of the Helm field in T. 17 S., R. 19 E. Fifty producing wells are now on this anticline, which in 1949 produced 966,335 barrels of oil and 1,824,156 thousand cubic feet of gas from Temblor and Eocene sands.[68]

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[62] Annual Review, Petroleum World, p. 45, 1941.

[63] Annual Review, Petroleum World, p. 90, 1943.

[64] Summary of operations, California oil fields: California Div. Oil and Gas, pp. 27, 71, July-December 1949.

[65] Frame, R. G., Helm oil field in Summary of operations, California oil fields: California Div. Oil and Gas (in press).

[66] Summary of operations, California oil fields: California Div. Oil and Gas, pp. 27, 71, July-December 1949.

[67] Summary of operations, California oil fields: California Div. Oil and Gas, pp. 27, 71, July-December 1949.

[68] Summary of operations, California oil fields: California Div. Oil and Gas, pp. 27, 71, July-December 1949.

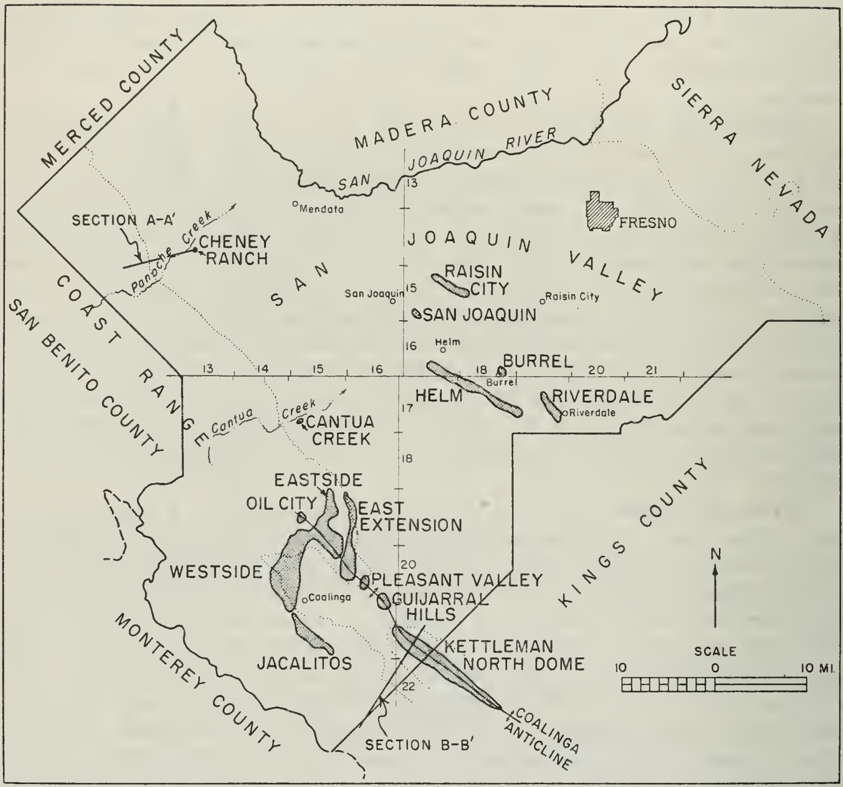
MERCED COUNTY
MADERA COUNTY
SAN JOAQUIN RIVER
SIERRA NEVADA
Mendota
FRESNO
SECTION A-A'
Panoche Creek
CHENEY RANCH
SAN JOAQUIN VALLEY
RAISIN CITY
San Joaquin
Raisin City
SAN JOAQUIN
COAST RANGE
SAN BENITO COUNTY
Helm
BURREL
Burrel
HELM
RIVERDALE
Riverdale
13
14
15
16
17
18
20
21
22
Cantua Creek
CANTUA CREEK
EASTSIDE
OIL CITY
EAST EXTENSION
KINGS COUNTY
WESTSIDE
PLEASANT VALLEY
GUIJARRAL HILLS
Coalinga
N
MONTEREY COUNTY
JACALITOS
KETTLEMAN NORTH DOME
SCALE
10
0
10 MI.
SECTION B-B'
COALINGA ANTICLINE

FIGURE 3. Western part of Fresno County showing oil-producing areas (stippled) and lines of structure sections A-A′ and B-B′.

San Joaquin Area. The San Joaquin area is a small productive area about 5 miles north of the Helm field where Eocene production was established in 1947. Data on this field are limited, but it is apparently an anticlinal accumulation. In 1949 six wells in this field produced 135,826 barrels of 30° to 31° gravity oil.[69]

Exploratory Wells Drilled in Fresno County

The California Division of Oil and Gas publishes a series of oil field maps showing land grids, oil field outlines, property lines and ownership. These maps also show all producing wells, abandoned wells and dry holes drilled within the confines of each map. Four such maps fall wholly or partly within Fresno County. The outlines of these maps, and their designating numbers have been plotted on the Fresno County map accompanying this report. These oil field maps can be obtained from the Division of Oil and Gas at their main office in the Ferry Building, San Francisco, or at their various branch offices.

The list of dry holes accompanying this report includes wildcats drilled in Fresno County which are outside the confines of the Division of Oil and Gas maps.

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[69] Summary of operations, California oil fields: California Div. Oil and Gas, pp. 27, 71, July-December 1949.

Dry holes drilled outside present limits of Division of Oil and Gas maps in Fresno County
Dec. 1, 1950

Location				Name of well	Date started	Year abandoned	Total depth in feet	Geology at bottom
11S	13E	25	MD	Continental Oil Co.----Continental-Gulf Miller-Lux Community 1	12–45	'46	3,985	M. Eocene
11S	13E	30	MD	Gay, D. M.----Friant Dome 1	6–41	'43	220	Pleistocene
11S	21E	31	MD	San Joaquin Oil & Dev. Assn.----No. 1	Pre-1925		2,500	Miocene ?
12S	11E	12	MD	Bergman Oil Co.----Ora Loma Farms 1		'35	6,008	Cretaceous
12S	11E	12	MD	Milham Expl. Co.----Ora Loma 1		'35	5,802	Cretaceous
12S	11E	28	MD	Hewitt Oil Co.----No. 1		'35	5,065	Cretaceous
12S	12E	7	MD	McClanaham Oil Co.----Oro Loma Farms 1	7–49	'49	4,600	----------
12S	20E	1	MD	Clovis Oil Co. (2) Central Valley Oil Co. (1)----No. 1	10–37	'39	1,194	Basement
12S	21E	18	MD	Fresno Madera Oil Co. (Harris. C.C., Trustee)----No. 1		'34	4,382	Schist
13S	11E	21	MD	Los Banos Oil Co.----No. 1		'24	3,432	Cretaceous
13S	11E	22	MD	Helen D. Oil Co.----No. 1	Pre-1925		200	Pleistocene
13S	12E	13	MD	Union Oil Co. of Calif.----Irvine 65-13	8–45	'45	6,829	Cretaceous
13S	12E	33	MD	Richfield Oil Corp.----Stone-Bragg 1	7–41	'41	5,724	Cretaceous
13S	13E	2	MD	C. W. Colgrove----Hotchkiss 15-2	10–49	'49	6,399	----------
13S	13E	35	MD	Emerich Oil Corp., Ltd.--Mason 1		'35	4,557	Kreyenhagen
13S	16E	22	MD	Edison Securities Co.----Comm. A 53-22	10–50	'50	4,648	Green ss 4596′
13S	16E	35	MD	Associated Oil Co.----No. 1		'26	5,737	Cretaceous
13S	16E	35	MD	Rio Grande Oil Co.----Edison 1		'30	4,980	Eocene
13S	16E	36	MD	Associated Oil Co.----No. 1		'27	5,078	Eocene
13S	17E	14	MD	Rio Grande Oil Co.----Mosesian 1		'30	4,971	Eocene
13S	17E	30	MD	Richfield Oil Corp.----Ponte 1	1–42	'42	8,797	Cretaceous
13S	17E	30	MD	Richfield Oil Corp.----Burns 1	8–42	'42	3,736	Miocene
13S	17E	32	MD	L. M. Lockhart----Kerckoff 1-32	11–49	'49	6,310	Sand w/streaks of shale.
13S	22E	5	MD	Taylor Oil Co.----No. 1		'27	2,120	Basement
14S	11E	12	MD	Gautier, James A.----No. 1	10–37	'39	562	Cretaceous ?
14S	11E	12	MD	Gautier, James A.----No. 2	2–38	'39	638	Cretaceous ?
14S	11E	12	MD	Gautier, James A.----Gautier 3	4–38	'39	800	Cretaceous ?
14S	12E	28	MD	Jergins Oil Co.----Escarpado 48	10–48	'48	4,300	Cretaceous ?
14S	12E	32	MD	Jergins Oil Co.----Escarpado 1	11–47	'47	3,363	Cretaceous
14S	12E	32	MD	Merced Oil Co.----No. 1		'27	2,140	Cretaceous
14S	13E	30	MD	Jergins Oil Co.----Cheney Ranch 3		'42	7,702	Cretaceous
14S	15E	29	MD	L. M. Lockhart----McNear 1-29	2–50	'50	6,756	----------
14S	16E	3	MD	Herndon, Sam B.----Bottoms 1	9–41	'41	5,571	Cretaceous
14S	16E	12	MD	Amerada Petroleum Corp.----Mendota Irriga. dist. 53-12	11–43	'43	5,500	Cretaceous
14S	16E	17	MD	Seaboard Oil Co.----Wilson 1	3–50	'50	6,401	Zilch 4145′ Kreyenhagen 5273′ Domengine 5586′ Dos Palos 5630′ Cretaceous 5719′ Wheatville 5900′
14S	16E	22	MD	Elmer C. von Glahn----Kerckhoff 1-62-22	2–50	'50	6,226	Kreyenhagen 5381′ Surflah ss 5618′ Domengine 5723′ Cretaceous 5810′ Wheatville 5990′
14S	16E	36	MD	Lytle, Lowery R.----Petrol Kerchoff 1	9–47	'47	6,410	Eocene
14S	17E	28	MD	Seaboard Oil Co. of Delaware----Seaboard-Tide Water Assoc. 1-28	2–44	'44	6,475	Cretaceous
14S	18E	27	MD	Harry Long----Lowe 51-27----	12–48	'49	5,422	Zilch 3610′
14S	18E	32	MD	Justice & Ellerby----No. 1		'33	3,637	Miocene
14S	20E	23	MD	Fresno Assoc., O. & G. Co.--No. 1		'28	575	Pleistocene
15S	12E	21	MD	Kern, John			3,000	----------
15S	12E	26	MD	Western Gulf Oil Co.----Lillis-Welch 1		'30	5,624	Eocene
15S	12E	32	MD	Ohio Well		Pre-1936	1,600	----------
15S	12E	36	MD	Seaboard Oil Co. of Delaware----Lillis 85-36	5–47	'47	6,059	Cretaceous
15S	13E	22	MD	Pure Oil Co.----C. L. G. 1	7–42	'42	7,000	Cretaceous
15S	14E	24	MD	Shell Oil Co.----Coffin 1	7–50	'50	7,437	----------
15S	15E	17	MD	Union Oil Co.----Nicholson 1-17	12–37	'38	7,062	L. Eocene
15S	15E	22	MD	Shell Oil Co., Inc.----Henderson 66-22	9–42	'43	12,918	Cretaceous
15S	15E	35	MD	Shell Oil Co., Inc.----S. P. 73-35	11–43	'44	8,100	M. Eocene
15S	20E	17	MD	Cornell & Givan----Fresno 1		Pre-'25	2,651	----------
15S	23E	5	MD	Riverbend Oil Corp.----Guggenhime 1	9–47	'47	1,401	Basement
15S	23E	23	MD	Amerada Petroleum Corp.----Community 2-1	3–44	'44	1,010	Basement
15S	23E	25	MD	Amerada Petroleum Corp.----Community 5-1	3–44	'44	815	Basement

Dry holes drilled outside present limits of Division of Oil and Gas maps in Fresno County Dec. 1, 1950—Continued

Location	Name of well	Date started	Year abandoned	Total depth in feet	Geology at bottom
15S 23E 36 MD	Amerada Petroleum Corp.--------Community 6-1	4–44	'44	1,088	Basement
16S 12E 22 MD	Ohio------------------No. 1		Pre-'36	1,500	------------------
16S 12E 25 MD	Standard Oil Co.-------- Bates 1		Pre-'25	3,869	Cretaceous
16S 13E 25 MD	Union Oil Co.-----------Lillis 1		'21	1,531	------------------
16S 13E 9 MD	Union Oil Co.-----------Lillis Welch 2		'25	2,528	------------------
16S 13E 10 MD	Seaboard Oil Corp. of Delaware--------Welch 1		'36	4,445	Cretaceous
16S 13E 20 MD	Superior Oil Co.---------Ciervo Unit Plan 1		'38	6,001	Cretaceous
16S 13E 22 MD	Seaboard Oil Co. of Delaware--------Seaboard-Pure 54–22	6–44	'44	7,016	Cretaceous
16S 14E 3 MD	Standard Oil Co. of California--------Paterson 74	11–44	'45	8,710	Cretaceous
16S 14E 11 MD	Pacific Western Oil Corp.--------White-B 65	5–48	'48	7,800	Eocene
16S 14E 18 MD	Harmon, A. K. P.-------No. 1		Pre-'25	500	Pleistocene
16S 14E 26 MD	Logan, J. E. Jr.---------Yearout 44	4–40	'40	9,001	Eocene
16S 14E 30 MD	Seaboard Oil Corp. of Delaware--------Lillis 1		'36	3,243	Cretaceous
16S 14E 35 MD	Crome Oil Co.----------Snyder 1	8–48	'48	6,351	Oligocene
16S 15E 7 MD	Texas Co., The---------Dahlgren 1	12–46	'47	7,847	Eocene
16S 15E 16 MD	Texas Co., The---------Shiells Co. 1	1–46	'46	8,386	M. Eocene ?
16S 15E 23 MD	Texas Co., The---------California-Cotton 36-23	10–44	'45	9,320	Cretaceous
16S 15E 23 MD	Havenstrite Oil Co.------Rawn 1	11–49	'49	7,617	Kettleman ss 5865′ Big Blue 6105′ Marine Temblor 6520′ Base Lower Variegated 7035′ Basal Temblor 7595′
16S 15E 30 MD	Mohawk Pet. Co.-------Langdon 1		'36	6,935	Eocene
16S 15E 32 MD	Western Gulf Oil Co.----Skelly Est. 1		'37	6,578	Eocene
16S 16E 18 MD	Standard Oil Co. of California--------Giffen 74	3–45	'45	10,100	Cretaceous
16S 16E 32 MD	Richfield Oil Corp.------McDonald Estate 1	3–42	'42	9,315	Cretaceous
16S 16E 36 MD	Norris Stamping and Mfg. Co.--------Cross 1	2–46	'46	8,729	M. Eocene
16S 22E 22 MD	Erickson & Swanson----Gravander 2	3–40	'41	1,620	Miocene ?
16S 22E 22 MD	Erickson, E. G.---------Gravander 1	9–39	'40	853	Miocene ?
16S 22E 29 MD	Superior Oil Co., The---White 1	12–42	'43	5,468	Basement
16S 23E 28 MD	Frakes Oil Co.----------Toscon 1	12–46	'48	3,000	Basement
17S 13E 6 MD	Seaboard Oil Co.--------Hagood 2	7–41	'41	4,589	Cretaceous
17S 14E 3 MD	Standard Oil Co. of California--------88	2–44	'44	6,934	M. Eocene
17S 14E 4 MD	Western Gulf Oil Corp. -Lillis 84-4	5–49	'49	5,469	------------------
17S 14E 4 MD	Western Gulf Oil Corp. -Lillis 22-4	9–49	'49	4,657	------------------
17S 14E 16 MD	Superior Oil Co.---------Lillis-Welch 1		'27	2,203	Eocene
17S 14E 16 MD	Seaboard Oil Co. of Delaware----------Core Hole 5	5–46	'46	3,118	L. Eocene
17S 14E 35 MD	Western Gulf Oil Co.----Lillis 82-35	1–50	'50	3,590	Kreyenhagen Shale 3356′
17S 15E 3 MD	Western Gulf Oil Co.----S.P. Land 3		'37	8,542	Eocene
17S 15E 3 MD	Cantua Creek Oil Co.----Southern Pacific 1	6–47	'47	6,552	Miocene
17S 15E 4 MD	Bankline Oil Co.--------Kenyon 1	7–46	'46	6,675	Miocene
17S 15E 4 MD	Richfield Oil Corp.------Turk 1	7–39	'39	9,000	Eocene
17S 15E 10 MD	Wilshire Oil Co.---------Cantua Co. 22	4–49	'49	6,894	------------------
17S 15E 11 MD	Western Gulf Oil Co.----S. P. Land 2		'34	7,379	Eocene
17S 15E 13 MD	Texas Co., The---------S. P. 27-13	1–41	'41	9,673	Eocene
17S 15E 14 MD	Richfield Oil Corp.------Richfield Cantua Land Co. 1	3–43	'43	5,100	Miocene
17S 15E 15 MD	Tide Water Assoc. Oil Co.--------S. P. 82	11–44	'45	13,019	Cretaceous
17S 15E 15 MD	Western Gulf Oil Co.----S. P. Land 1		'34	8,868	Eocene
17S 15E 17 MD	Russell Giffon----------S. P. 33-17	7–50	'50	9,900	Hondo shale
17S 15E 24 MD	Texas Co., The---------Everding 1	8–40	'40	10,307	Cretaceous
17S 15E 25 MD	Continental Oil Co.------S. P. 1	7–49	'49	10,342	------------------
17S 15E 36 MD	Superior Oil Co., The---Cantua Land 54-36	3–43	'43	10,729	Cretaceous
17S 16E 12 MD	Texas Co., The---------Loescher 1	5–39	'39	9,631	Eocene
17S 16E 13 MD	Superior Oil Co., The---K. C. D. 1	9–46	'46	10,510	Eocene
17S 16E 25 MD	Superior Oil Co., The---Harnish Bros. 1	6–48	'48	11,029	Cretaceous
17S 16E 30 MD	Shell Oil Co., Inc.-------Port Costa 48-30	4–39	'39	10,711	Eocene
18S 15E 18 MD	Sharples Oil Corp., The-Lillis 88	9–47	'47	5,581	Eocene
18S 15E 27 MD	Standard Oil Co.--------Domengine 1		Pre-'25	4,200	Eocene ?
18S 15E 34 MD	Tavern Oil Co.----------No. 1			2,265	Eocene
18S 15E 34 MD	Wilshire Oil Co., Inc.---Imperial 1	11–43	'43	2,250	U. Eocene
18S 15E 34 MD	Sharples Oil Corp., The-Sharples-52-Jordan	12–47	'48	3,217	Eocene

Dry holes drilled outside present limits of Division of Oil and Gas maps in Fresno County Dec. 1, 1950—Continued

Location				Name of well	Date started	Year abandoned	Total depth in feet	Geology at bottom
18S	15E	35	MD	Sharples Oil Corp., The-Sharples-73-Domengine	8–48	'48	8,600	Eocene
18S	16E	15	MD	Superior Oil Co., The---S. P. L. 1	6–39	'39	11,442	Eocene
18S	16E	25	MD	Humble Oil & Refining Co.---- ----S. P. R. R. Co. 1	4–49	'49	11,415	--------------------
18S	17E	31	MD	Pure Oil Co., The------S. P. L. 1	9–37	'38	11,236	M. Eocene
19S	13E	19	MD	Gatos Creek Oil Co.-----No. 1	7–39	'44	1,151	Pliocene
19S	16E	23	MD	Superior Oil Co.---------S. P. L. 48-23	9–49	'49	10,595	--------------------
19S	16E	27	MD	Superior Oil Co.---------S. P. L. 33-27	10–48	'49	11,274	Shale
19S	18E	15	MD	Shell Oil Co.-----------Boston Land Co. G		'29	1,009	Tulare
19S	18E	26	MD	Shell Oil Co.-----------Boston Land Co. B		'29	3,701	Tulare ?
20S	13E	20	MD	Bald Mountain Dr. Co.-No. 1		'26	----------	--------------------
20S	13E	29	MD	Van Atta, J. Walter & Associates---- ----Van Atta 1	11–47	'48	2,292	Cretaceous ?
20S	18E	6	MD	Shell Oil Co.-----------Boston Land Co. E		'29	3,607	Tulare ?
20S	18E	11	MD	Shell Oil Co.-----------Boston Land Co. F		'29	1,856	Tulare
20S	18E	13	MD	Seaboard Oil Corp. of Delaware (Milham-Seaboard?)----------Boston Land 1		'36	3,501	Etchegoin ?
20S	18E	14	MD	Texas Co., The---------Boston 1	1–40	'40	10,747	Miocene
20S	18E	34	MD	Triumph Oil Co.--------Farrand 3	4–50	'50	10,250	--------------------
21S	13E	8	MD	Worthen Canyon Oil Co.		'35	921	--------------------
21S	14E	19	MD	Dauphin Dev. Corp.-----No. 1	8–38	'39	4,581	L. Miocene
21S	14E	28	MD	Currency Pet., Inc.------No. 1		'30	3,610	Cretaceous
21S	14E	30	MD	Dauphin Dev. Corp.-----Boone 1	1–37	'38	3,755	L. Miocene
21S	16E	30	MD	The Texas Co.----------Raath 1	8–49	'49	6,768	Base McLure 5623′ Kreyenhagen 6703′
21S	16E	30	MD	Jacalitos Oil Co.---------Plaugher 1	3–45	'45	4,469	Cretaceous
21S	16E	32	MD	Texas Co., The---------Ferguson 1	8–42	'42	7,214	Eocene
22S	16E	4	MD	Continental Oil Co.------Kreyengahen 1		'40	11,020	Cretaceous
22S	16E	6	MD	Superior Oil Co.---------Mantes 1		'34	7,838	Domengine
22S	16E	6	MD	Texas Company, The---Hawxhurst 11-6	8–44	'44	4,857	U. Miocene
22S	16E	6	MDq	Standard Oil Co. of California---- ----Ferguson 54	9–45	'46	7,782	Cretaceous
22S	16E	6	MD	Standard Oil Co. of California---- ----Ferguson 21	8–47	'47	7,525	Cretaceous
22S	16E	7	MD	Miley, E. J.------------No. 1		Pre-'25	5,264	Kreyenhagen
22S	16E	8	MD	Shell Oil Co., Inc.-------Kreyenhagen 23-8	8–46	'46	7,051	U. Eocene
22S	16E	33	MD	Richfield Oil Co.--------Schrock 1		'30	3,434	Cretaceous
22S	16E	33	MD	Taft Well Drilling Co.--No. 1		'35	5,005	Eocene ?
22S	16E	33	MD	Oceanside Oil Co.-------No. 1		'31	660	Temblor
22S	16E	33	MD	MCA Drilling Co.-------Kreyenhagen 1		'39	2,003	Temblor
22S	16E	33	MD	Texas Co., The---------Kreyenhagen 2	12–47	'48	550	Miocene
22S	16E	33	MD	Texas Co., The---------Kreyenhagen 1	11–47	'47	1,200	Miocene

Pumice and Pumicite

The volcanic ash beds found near Friant on both sides of San Joaquin River were worked occasionally to supply material for making polishing and cleaning powders and scouring soaps, but it was not until about 1927 that production of the Fresno County deposits began on a substantial scale.

Pozzuolana (also pozzolan and puzzolan) and trass are Italian and German names respectively for volcanic material similar in origin to pumicite, but consolidated as tuff. Originally this material was a finely powdered substance composed of very small, sharp, angular pieces of volcanic glass ejected by volcanoes during explosion eruptions. The particles may be carried long distances from the source by the wind, or may be transported by water, as was the case with the pumicite in this part of Fresno County. The more acid type resembles granite in chemical composition. It often contains considerable pumice in small lumps. This acid type is composed mostly of silica, but contains alumina, iron oxide, and some lime, magnesia, and potash.

The Romans used pozzuolana and lime to make a long-lived cement. In modern times this class of material, sometimes made artificially from slag, has been found beneficial as an admixture with Portland cement used in concrete that is to be exposed to water. The chemical composition of the cement, the aggregate, and the pumicite must all be studied to obtain best results.

Besides the saving in cost resulting from the substitution of pumicite for part of the cement, the use of pumicite reduces the speed of reactivity of the alkali in the cement or aggregate, furnishes material which combines with possible excess caustic lime to form silicate or aluminate, reduces cracks or crazing, and tends to reduce heat of reaction, which is important in the setting of large masses of concrete. When concrete is made with appreciable quantities of pumicite, it requires much longer to reach its maximum strength, some tests indicating an increase in strength for five years. Chemists with Yosemite Portland Cement Company [70] carried on experiments with different mixtures of Fresno County pumicite with different types of portland cement, to determine the maximum amounts of pumicite that could be added.

The Earlonite Mining Company and A. H. McKenzie produced pumicite from the Fort Miller Ranch deposit near Friant, between 1927 and 1933. The Fresno Irrigation District used this pumicite in concrete for several years and found it increased the density and workability. It was also used by makers of concrete pipe, who added 20 to 25 percent pumicite by volume to their mixes.

The area containing the Fort Miller Ranch Deposit is in the land covered by Millerton Lake formed behind Friant Dam, for which ground was broken November 5, 1939. The pumicite deposit was within 3 miles of the dam site, and it was tested for use in the dam. It was found that this pumicite could be substituted for 20 percent of the cement by weight without adversely affecting the ultimate strength of the concrete. This dam is the fourth largest concrete dam built up to this time. It required over 1,750,000 barrels of cement, 13,500,000 pounds of steel, 75,539 tons of pumicite (which replaced nearly 400,000 barrels of cement); and over 4,000,000 tons of aggregate. Aggregate was obtained from a deposit 2½ miles downstream from the dam on San Joaquin river. Friant Dam is 3,430 feet long, has a maximum height of 320 feet, and a maximum width at the base of 268 feet. It contains 2,100,000 cubic yards of concrete.

The use of pumicite was decided upon largely because it would lessen the quantity of heat liberated as the concrete hardened, would reduce the expenditure for cement, and because pumicite was available near the dam site. Control of heat was important because of the large blocks of concrete to be poured as units. Pumicite was mined in benches by power shovel, hauled by trucks to the dam site, where lumps were broken in rolls set to ¾-inch. Requirements for this use called for 95 percent of the pumicite to pass 325-mesh. All of the mass concrete in the dam, except that on the face of the spillway and the spillway apron, was made with eight-tenths of a barrel of cement, and two-tenths of a barrel of pumicite per cubic yard.

Other large engineering projects, which used Portland-pozzolan cement are: San Francisco Bay Bridge (San Francisco-Oakland) 104,-

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[70] Larmour, H. McC., McMasters, E. L., and Jacques, Wm., Evaluating a pozzolan: Rock Products, vol. 44, no. 3, pp. 52-56, 1941.

000 barrels of Portland-pozzolan cement; and Golden Gate Bridge (San Francisco-Marin County) 232,000 barrels of Portland-pozzolan cement.

The following is a description of the character and applications of pumicite obtained near Friant, sometimes referred to as "Fresno pumicite."[71]

> "The so-called Fresno pumicite has been used widely in concrete construction in California. For example, it was used in certain Los Angeles County Flood Control dams; and in thousands of feet of canal walls and appurtenant structures in the San Joaquin Valley. The pumice was substituted for 12.5 percent by weight of the Portland cement in 5,800 cubic yards of concrete in the outlet tower, gatehouse, and powerhouse at Pardee Dam, Calaveras County. Pumicite from a deposit about 2½ miles northeast of Friant was used to replace 20 and 25 percent by weight of the Portland cement in 1,750,000 cubic yards of mass concrete in Friant Dam, for an estimated saving of $301,000 in cost of cement. This pumicite occurs as layers of exceedingly fine, rhyolite tuff, 14 to 25 feet thick, in the vicinity of Friant, about 24 miles northeast from Fresno. The deposits represent a portion of the Friant formation of probably lower Miocene age."[72] "The strata of pumicite are interstatified with fine sand and the so-called pebble pumicite, which has been used as lightweight aggregate for concrete. In its natural state the pumicite is very fine; with 89 to 99 percent passing the No. 325 screen, and an average specific surface area of 6,550 $cm.^2/g.$ (Lea and Nurse method)"[73] "Specifications for the pumicite used in construction of Friant Dam required that at least 98 percent pass this screen.
>
> "Petrographically, the Friant pumicite is white to pale buff, and is composed of colorless, pumiceous glass with refractive index of 1.495 to 1,500, and a small proportion of mineral grains representing original phenocrysts, including quartz, sanidine, oligoclase, biotite, and hornblende. Many of the glass shards are altered at the edges and within vesicles to a montmorillonite-type clay, probably through the action of volcanic gases rather than by weathering. Typical chemical analyses indicate SiO_2, 69 to 74 percent; Al_2O_3, 11 to 15 percent; Fe_2O_3, 0.6 to 2.1 percent; CaO, 0.6 to 1.0 percent; MgO, 0.3 to 0.6 percent; Na_2O, 1.6 to 2.1 percent; K_2O, 3.5 to 5.4 percent; ignition loss, 4.2 to 5.2 percent. The specific gravity is about 2.34; weight per cubic foot of the pumicite used in Friant Dam was specified to be between 40 and 47 pounds."

In most ways the pumicite from near Friant produces a Portland-pozzolan cement similar to that produced by the tuff from near Monolith (Kern County), although somewhat superior in strength. However, both the Monolith tuff and the pumicite reduces the rate of hardening of the concrete, and thus may necessitate delay in removal of forms. In laboratory tests, resistance of a pumicite-Portland cement to a 10 percent solution of sodium sulfate was less than half that of a Monolith-tuff-Portland cement.[74] Compressive strength of Portland-pumicite mortar is increased slightly by calcination at 1,600° F. Freezing and thawing durability of concrete usually is reduced by use of a Portland-pumicite cement, but with certain Portland cements in combination with the pumicite, freezing and thawing durability is not decreased.

Besides the large quantity of pumicite taken from the Fort Miller property by the U. S. Bureau of Reclamation for use in Friant dam, arrangements were made under which the Bureau of Reclamation stockpiled for the owners of the land (McKenzie Estate), 103,000 cubic yards of pebble pumice on land above the high water mark. This stockpile is still practically untouched.

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[71] Mielenz, R. C., and others, Materials for pozzolan: a report for the engineering geologist: Research and Geology Div., U. S. Bur. Rec., Petrographic Lab. Rept. No. Pet-90B, pp. 7-8, 1950.

[72] Macdonald, G. A., Geology of the western Sierra Nevada between the Kings and San Joaquin Rivers, California: Univ. California, Dept. Geol. Sci., Bull. vol. 26, pp. 215-286, 1941.

[73] Lea, F. M., and Nurse, R. W., The scientific surface of fine powders: Soc. Chem. Ind., Jour., vol. 58, p. 277, 1939.

[74] Davis, R. E., and others, Properties of mortars and concretes containing Portland-pozzolan cements: Am. Concrete Inst., Prov., vol. 32, pp. 80-114, 1935.

Stone (Miscellaneous)

The San Joaquin River, forming the north boundary of Fresno County, has been the principal source of miscellaneous stone in the county.

The sand and gravel forming the bed, banks, and bars of the river are being actively exploited by a number of plants operating along the south side of the river between Friant and Herndon. The production includes washed sand and gravel, and crushed rock in all standard commercial sizes. The largest contract filled so far in which these materials have been used was for the construction of Friant Dam. Over four million tons of aggregate was taken from a deposit 2½ miles down stream from Friant for use in making concrete for the dam. In general, the gravel along this stream is mostly small to medium in size, with rather a high proportion of sand. A sample taken by the U. S. Bureau of Reclamation from material being put out by one of the operators may be taken as representative. This sample showed 7 percent granite, 25 percent gneiss and schist, 40 percent meta-diorite porphyry, 7 percent basalt.

Some production of rock, sand and gravel is also made from Kings River, particularly in the vicinity of Sanger.

Anderson Rock Company, P. O. Box 1372, Fresno, operates a rock, sand and gravel plant installed in 1947 at the former site of old Lanes Bridge on the east side of San Joaquin River in secs. 15, 16, T. 12 S., R. 20 E., 9 miles north of Fresno. J. C. and Hal Anderson have a 20-year lease. A Lorain gasoline-powered mobile dragline using buckets of 31-cubic foot or 1½-cubic yards capacity is used for digging sand and gravel from the river bank and for loading trucks, which haul about 7 cubic yards each, a quarter of a mile to the electrically-operated plant. Trucks dump from a ramp to a belt conveyor, which delivers material to a 4-inch screen to separate over-size cobbles for crushing. Screening produces seven sizes in the range ¼-inch to 4-inches. Sand is taken off with two drag classifiers. Gold-saving sluices have just been installed (April 1949).

Primary crushing is done with a 13- by 24-inch Farrell jaw crusher, and a 3-foot Symons crusher is used for secondary crushing. Crushed rock sizes include dust, ⅜-, ½-, ¾- and ¾-inch oversize. Crushed rock and gravel are used principally for concrete in highway and general construction and some sand is used for plaster. Some material is loaded in trucks directly from bins under the plant, but much of it is stored in open stockpiles from which trucks are loaded by ⅝- and 1-cubic yard mobile clamshell machines. The plant is operated one shift with a crew of 10 men and produces 700 to 800 tons daily.

Bent Company and Griffith Company, who shared the contract for furnishing labor and equipment used in building Friant Dam, operated a plant for processing sand and gravel from 1940 to 1942 inclusive on land owned by the United States on San Joaquin River 2½ miles downstream from the dam site, in Fresno County. The plant was designed to process 1000 tons an hour and was built by Stephens-Adamson Company, Los Angeles. Four sizes of gravel ranging from pea-size to 8½-inch cobbles, and two sizes of sand were prepared. After screening, the different sizes were stockpiled and fed through tunnels to belt conveyors for transport to loading hoppers. Gold was saved during the process. A railroad 2½ miles long was built from the gravel plant to the dam site for delivering aggregate to track hoppers from which it was taken by belt conveyor to the mixing plant. A total of 4,457,320 tons of aggregate was prepared for use in the dam.

Central Rock & Sand Company's plant is on Kings River 2½ miles east of Sanger. Wallace C. McAllister, P. O. Box 428, Sanger, is manager. This plant has been in operation 16 years; it has a daily capacity of 650 tons. Gravel is dug with a 2½-cubic yard Northwest power shovel and hauled in trucks to the plant where crushing and screening gives products ranging from concrete sand to 4-inch cobbles; but most sales are of crushed rock produced from hard ''niggerheads'' which predominate in the river gravel. A Sauerman dragline is to be installed for digging. Seven men are employed.

Clingan Flagstone deposit is covered by four locations (80 acres) owned by the Clingan family c/o William Clingan, Star Route, Orange Cove. The claims, which are at an elevation of 3000 feet, are 43 miles by road east of Fresno, adjoining Highway 180. Only a little work has been done and some of the stone has been hauled to Clingan's store on the highway 4 miles west of deposit. It is schist from a pre-Cretaceous roof pendent in granite.

Fresno County has operated a quarry for the production of decomposed ''granite'' in sec. 18, T. 11 S., R. 21 E., 2 miles southwest of Friant for 10 years. A Lorain diesel shovel with ½-cubic yard bucket is used for digging the soft, decomposed rock and loading trucks from the side of the road cut. The granite is used as a base and for shoulders and shallow fills on county roads. Five or more men are employed, depending on the demand for material.

Pacific Coast Aggregates, Inc. Rockfield Plant No. 124 is in sec. 36, T. 11 S., 20E., near the San Joaquin River and is served by spur track at Rockfield on the Southern Pacific Railroad. A. H. Sienknecht is superintendent and 20 men are employed. This plant was erected in 1924 by Service Rock Company. Of the original 600 acres about 100 acres have been dug in 25 years operation. Pacific Coast Aggregates, Inc., formerly operated a plant at Piedra but on July 1, 1938 combined with Grant-Service Rock Company to form the Grant-Pacific Rock Company, under which name operation was continued until recently. At present, about 1500 tons of rock are handled in 8 hours; although the plant was designed to handle more, changes in specifications for products in recent years have reduced output. Sand and gravel are dug from an old channel of the river with a 5-cubic yard Bucyrus dragline which has a boom 100 feet long and will dig to a depth of 50 feet. The material, about half sand and half gravel, is loaded into dump cars and hauled by Plymouth gasoline locomotive on broad gauge track half a mile to the plant. Here it is dumped in hoppers feeding a 36-inch belt conveyor which carries it to the top of the large plant, where the first separation of sand and gravel occurs in a 5-feet by 20-feet trommel with one 5-inch, one 3-inch and three 2-inch sections. The smaller sizes which fall through this trommel are separated on a 4-foot by 12-foot double shaking screen with 1-inch mesh on top and ¼- by ⅜-inch mesh on bottom screen. The sand passes to a gold saving plant with about 60 square feet of Hungarian riffles, and to drag classifiers which pull out fine and coarse sand for plaster and concrete; silt is carried away through 1000 feet of steel-lined launder. Washed gravel is stored in bins for loading into delivery trucks. The 13- by 24-inch Farrell jaw crusher and 4-foot and 3-foot cone crushers are on the lowest floor and receive feed from bins above, delivering their products to belt conveyors for storage. Thirteen sizes ranging from plaster sand up to 3-inch and 6-inch cobbles are sold. The cobbles are used especially for flood control work on Little Dry Creek by the federal government. With this exception, sizes of rock and gravel are standard, from 2½ inches downward, and used principally for highway and general construction. A cold mix plant using a process in which asphalt is crushed and applied with the other road-surfacing ingredients without heating is being perfected. The property has about 5 miles of standard gauge railroad tracks. Brownhoist locomotive cranes with clamshell buckets are used for loading railroad cars from stockpiles, and other heavy work.

River View Rock Company is in sec. 27, T. 12 S., R. 19 E., on San Joaquin River, 3 miles above Highway 99 crossing. River View is a subsidiary of Pollard Brothers, makers of concrete pipe. Most of the aggregate output from this plant is used for making concrete pipe at the Pollard Brothers' plant. The gravel plant began operations in September, 1947. It consists of a dragline for digging the gravel, crushers, and screening and washing plant. Seven rock sizes including sand are produced. The plant, to which 180 horsepower are connected, has a capacity of 800 tons of aggregate per 8-hour shift. Eight men are employed.

Thompson Materials and Construction Company's aggregate plant is in sec. 34, T. 21 S., R. 16 E., 6 miles northwest of Avenal. The plant is on the south side of Zapato Creek, half a mile west of Highway 41. Poorly-sorted terrace gravel is mined with a dipper-type power shovel from a bank 40-50 feet high. Trucks haul to the rock plant, about a quarter of a mile distant. The rock plant includes vibrating screens, primary jaw crusher, secondary cone crusher, washing plant, and open-air storage facilities. Products are several sizes of crushed rock and washed sand. Ready-mixed concrete facilities are operated in conjunction with the rock plant.

Stewart & Nuss, Inc., 410 Thorne St., Fresno, operate two plants on San Joaquin River for the production of sand, gravel and crushed rock. Charles Stewart and Claude Nuss control the company. This branch of the business is carried on under the title of Herndon Rock Products. Ben. J. Evenett is the general plant superintendent.

No. 1 plant is on the river near the state highway at Herndon. It has a capacity of 200 tons an hour and at present is being operated 8 hours a day. About 21 men are employed. Sand and gravel are dug with a 2½-cubic yard Northwest No. 80 D dragline and hauled in loads of 22 tons each in trucks, which dump to a belt conveyor. The latter elevates material to a primary trommel 12 feet long which takes out all material over 3 inches. The material under 3 inches in size goes to the gravel screen and through a series of screens which separate all the standard sizes between 3 inches and ⅜-inch. Sand is washed and stockpiled in the open for further handling. The oversize from the primary screen passes to two 3-foot Symons cone crushers. These produce all sizes of crushed rock from 1½ inches down to screenings. Five power-shovels and draglines ranging from 1 cubic yard to ⅜ cubic yard capacity are used at the plant for stockpiling, reclaiming the different sized products and for loading trucks. One dragline of ¾ cubic yard capacity on crawler treads is used for reclaiming sand, loading the sand bunker and loading trucks.

The sand washing plant is at present being equipped to save gold. In connection with the No. 1 plant, the company operates a hot asphalt plant with a maximum capacity of 1750 tons of asphalt mix a day. This is a regular Madsen hot plant handling batches of 4000 pounds. Oil is heated by steam to a temperature of 200° to 350° F. depending upon the type of oil used. This asphalt plant is having a new tunnel completed for supplying sand, and it is anticipated that this change will increase the capacity considerably.

The No. 2 plant is on San Joaquin River about 5 miles upstream from Herndon. It is equipped to produce only washed sand and gravel, and is temporarily idle while changes are being made. The company owns and leases about 400 acres on the San Joaquin River.

Tivy Valley Granite Pit is in Tivy Valley 5 miles by road northeast of Minkler. C. W. Turnage & Son, 1218 Q Street, Sanger, own and operate it at present, but it has been worked intermittently for 30 years. Here decomposed granite forms a small hill which has been worked to a depth of 110 feet. The bank is drilled with down holes $1\frac{1}{4}$ inches in diameter, two holes being blasted at a time. A $\frac{1}{3}$-cubic yard Kinsley shovel operated by gasoline engine is used for loading trucks. The product is sold principally for use on roads and walks.

Tungsten

No tungsten production from Fresno County was recorded during World War I although claims had previously been located. The deposit at the Garnet Dike mine, which proved to be the principal source during World War II was discovered by Clarence Quigley in 1918. Several other properties produced small quantities of tungsten up to 1944, but work practically ceased with the removal of the premium price, except at the Garnet Dike mine, which has been closed by litigation.

The tungsten mineral, scheelite, has been found in this county in contact metamorphic deposits which were formed by the action of heat and solutions from intrusive granitic magma acting on limestone layers in rocks of the Carboniferous series and possibly others of pre-Cretaceous age intruded by the Sierra Nevada batholith along the western front of the Sierra Nevada. From Mariposa County southward the erosion of this once thick cover of older rocks has been carried out extensively and deeply enough to remove it completely in many places and elsewhere has reached the zone of contact metamorphism where action was intense enough to form of a new series of minerals, resulting in a rock called tactite.

Tactite is characterized by a wide variety of silicate minerals, including reddish-brown garnet, green epidote and black hornblende. If scheelite occurs, it is generally one of the minerals in tactite. Owing to the mode of formation, the ore is generally erratic in occurrence, and deposits are irregular in shape and expensive to prospect and mine. The ultraviolet lamp is a necessity in both prospecting and mining of this scheelite, which is difficult to distinguish otherwise from some light-colored silicates and quartz.

Benson scheelite prospect in sec. 18, T. 11 S., R. 25 E., is on land owned by Jack Simpson, three quarters of a mile due south of the Rabbit's Foot claim. Alfred Benson, who worked it in 1942-43, states that on the surface scheelite occurred over a length of 50 feet and a width of 4 feet. On sinking this showing proved to be only a small wedge which pinched to a width of 2 inches at 20 feet in depth. It was abandoned after producing about $1000 worth of ore.

W. M. Clingan, Star Route, Orange Cove, has 120 acres of land in NW¼ sec. 32, T. 13 S., R. 26 E. which shows prospects of ''float'' scheelite at several places, and the outcrop of a vein 1 foot wide. Numerous other shallow tungsten prospects were noted in the vicinity of Clingan's Store during the early part of the war and some small lots of tungsten ore were gathered and shipped, but no work was going on at time of visit. This district is on the Kings Canyon Highway, 39 miles east of Fresno at an elevation of 1800 feet.

Garnet Dike tungsten mine contains two lode claims in sec. 22, T. 12 S., R. 27 E., 3 miles by steep road north of Kings River and 22.6 miles east of Trimmer by road. The elevation ranges from 2800 to 3000 feet. The deposit was discovered in 1918 by Clarence Quigley and was worked by Sheridan Bros. and Mrs. Bennett from 1940 to 1947. The property was idle when visited October 19, 1948, due to pending litigation. It has been the most important tungsten producer of the county. When first opened, the mine was accessible only by pack trail, and larger items of equipment had to be dismantled or cut up and packed piecemeal. Concentrate has been hauled 60 miles to Fresno. Because of the lawsuit, many details cannot be published.

Here scheelite occurs in a tactite zone striking northeast for about 200 feet in granite country rock intruded by nearly horizontal sills. The workings consist of open cuts and a series of 4 crosscut adits with drifts and open stopes of ore. The total amount of underground workings is several thousand feet. The ore occurs in chimneys standing vertical, with a maximum diameter of 60 feet. The workings have opened a vertical range of about 200 feet but the lowest adit, 250 feet long in October 1948, had not yet reached the ore when work was suspended.

The ground is generally hard and tight, but caverns are in the unaltered limestone in one wall. Ore is taken by a short tramway to the mill. At the mill ore is crushed to ½ inch with primary and secondary Alloy Steel crushers and fed by belt conveyor to a Wheeler mill, which handles 2½ tons an hour. Concentrate is saved on an 18-foot Wilfley-type table. The first cut concentrate carries 11 percent to 14 percent bismuth, and up to 60 percent WO_3; the second cut contains 70 percent or more WO_3; the third or middling cut contains 40 percent or more WO_3. The fourth cut is pumped back to the mill for regrinding. Power is furnished by an automobile engine.

Houghton Brothers have 12 tungsten claims on lower Dinkey Creek about in E½ sec. 3, T. 12 S., R. 26 E., 2 miles north of Balch Camp. J. B., E. C., and R. J. Houghton began work in 1942 when a mill of 20 tons capacity was installed and started. The mine sometimes referred to as the Kings River Tungsten mine, was a small producer during the war years and has been one of the few on which any work has been done the past two years. Work was principally in open cuts. In 1948, a few hundred pounds of concentrate was produced.

Quigley Kings River (Baziok, Beziuk) mine is in NE¼ sec. 22, T. 12 S., R. 27 E., adjoining the Garnet Dike mine on the northwest, and 22½ miles east of Trimmer by road. When the 13 claims were first located and worked, they were reached only by 7 miles of pack trail. The mine was equipped with a mill and tramway and began production in 1940.

The Kings River Mines, a corporation, took it over in 1942 and continued operation until 1944. Ore was mined in open cuts from a ''blanket'' deposit and was milled in a 25-ton mill. No work has been done since 1944. The claims are on the steep slope at an elevation of 2800 to 3000 feet, 3 miles by road north of Kings River and 1500 feet higher. The ore came from the exposed part of a deposit similar to that in the adjoining Garnet Dike mine. Good ore was found to be erratically distributed, but substantial production, possibly as much as $75,000 gross, was made.

Lucky Clover tungsten mine is in sec. 29, T. 13 S., R. 26 E., 1 mile north of Clingan's Store near Highway 180 and 40 miles east of Fresno by road at 1800 feet elevation. The owner is Sam Davis, Bar-7 Guest Ranch, Dunlap. Four successive lessees have worked here on a small scale since 1942. The last of these were C. L. Hilton and associates, who began work in November 1947, but quit when the shaft caved early in 1948, and only meager information is available as the workings cannot be entered. Scheelite associated with garnet and epidote occurs in the contact zone between pre-Cretaceous rocks containing limestone and granite. The vertical shaft is 70 feet deep, and a short incline and a short drift were run to the west. Equipment includes a single-drum hoist with 15-horsepower electric motor, skip, Ingersoll-Rand portable air compressor with 4-cylinder gasoline motor, a Caterpillar tractor connected to a 60-Kilowatt 90-ampere electric generator, a 3-inch discharge 4-stage Byron Jackson pump with a 40-horsepower electric motor, and pipe line. Milling equipment includes a gyratory and two jaw crushers, Wheeler ball mill, several table concentrates and a Denver jig. Part of this is housed in a mill building and has been used for crushing a small amount of ore. A few tons of scheelite concentrates has been sold.

Clarence Quigley, Trimmer Route, Sanger, California, has several tungsten claims in the vicinity of the Garnet Dike mine, including some formerly worked by Kings River Mines. The property, also known as Baziok and Beziuk, is now called the Greenstone and Molybdenum Canyon claims. Both of these were productive before 1945, but have since been idle. Quigley also has a tungsten prospect on the Bunch Rock claim, on which 100 feet of work has been done. A mile of road is needed to reach this claim from the Garnet Dike mine road.

Rabbit's Foot tungsten claim is in sec. 7, T. 11 S., R. 25 E., 1½ miles by Forest Service road from Trimmer and is at an elevation of about 3300 feet. J. A. Reiss and Marguerite Reiss, 3635 Kerckhoff Avenue, Fresno, are the owners. A deposit from which ore was last milled in 1943 was worked by a shallow open cut 20 feet by 30 feet and a shaft 25 feet deep, which was caved when visited. No drifting was reported. Nearby, a notice on the Rabbit's Foot claim indicates the ground was located prior to July 1, 1940. The work here consists of a small open cut 36 feet long (October 18, 1948) and 10 to 12 feet deep, with a branch cut of about 10 feet. The contact metamorphic zone is exposed on a small knoll for a width of 35 feet striking N. 10° W. A small open-grid mill about 3 by 4 feet and Risdon rock crusher were used to crush ore from the shaft and open cut first mentioned and a small amount of scheelite concentrate was saved. The property was idle when visited October 18, 1948. Ultraviolet light showed a small amount of scheelite in specimens from the recent workings.

Red Bud (Spanish Peak) tungsten mine is in E½ sec. 15, T. 11 S., R. 24 E., on a branch of Sycamore Creek. Al Feuerstein, 3863 Kerckhoff Avenue, Fresno, leases 80 acres of land on the Spencer ranch for mining; no work has been on the tungsten ore since 1945, but at present limestone is being quarried and crushed (see under Limestone). Scheelite occurs with tactite in a contact zone striking N. to N. 20° W. along the creek at an elevation of 1500 to 1600 ft. The footwall is granite, and hanging wall is limestone. Feuerstein, working alone, mined small tonnages of tungsten ore from three shallow openings in a length of 100 yards. The deepest work was a shaft 14 feet deep in the creek bed near the mill, where he reported the ore was from a few inches to 3 feet wide. On another vein about 250 feet west, striking north, small open cuts also yielded a few tons of ore. The mill used to recover scheelite has been converted to crush and size limestone. The total value of the tungsten production was a few thousand dollars.

The Jack Pot tungsten mine is half a mile west of the Red Bud mine. No work has been done there recently.

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TABULATED LIST OF FRESNO COUNTY MINERAL DEPOSITS

The following table lists Fresno County mineral deposits in alphabetical order. The number in the first column refers to the map, plate 31. The mineral produced by each mine is given under the colum ''Remarks''. Unless otherwise indicated, all bibliographic references in the last column are to publications of the California Division of Mines. The following abbreviations are used in these references: B—Bulletin; R—Report. The number following the colon is the page reference.

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Adrian Alexander						See Red Bud
65	Anderson Rock Co.	Anderson Rock Co.	15,16	12S	20E	MD	Produces miscellaneous stone and gold. (Herein)
55	Anita (Rita, Sta. Reta)	Anita Mining Co., lessee 1942	17	18S	13E	MD	Produces mercury. (Herein)
56	Archer Mercury	Ben J. Byles, Box 667, Coalinga, owner, Archer Mining Co., 510 S. Spring St., Los Angeles, lessee.	2,3	19S	13E	MD	Produces mercury. R 25:329; B 142:174; R 35:376-377; B. 78:43. (Herein)
	Atchison, Topeka & Santa Fe Railway Co.	Atchison, Topeka & Santa Fe Railway Co., 121 E. 6th St., Los Angeles					Produces stone, miscellaneous. B 142:181. Idle 1948-50.
	Aurecoechea						See Mercey
	Avery	George D. Avery, Porterville		21S	14E	MD	Produces manganese. Undeveloped. B152:53; B 125:112
	Bachler						See Fresno
2	B.B	Berthol Linderman, et al	SW¼ 24	11S	23E	MD	Produces chromite. B 134, pt. III:78. Mined out
38	Bahr Gypsum	Rt. 1, Box 364, Kerman	1	16S	12E	MD	Produces gypsum. (Herein)
	Balch						See McBride tungsten property

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
61	Balsam Grove Springs	Sierra Methodist Chautauqua & Bible Conference Assoc., 407 Cory Bldg., Fresno	32	8S	25E	MD	Produces mineral water. R 14:456; R 25:319
	Baziuk						See Quigley Kings River
	Benson Brothers						See Benson Scheelite
	Benson-McMurty						See Benson Scheelite
74	Benson Scheelite (Benson-McMurty; Benson Brothers)	Jack Simpson	NE$\frac{1}{4}$18	11S	25E	MD	Produces tungsten. (Herein)
66	Bent & Griffith Co. (1940-42)	U.S. Government	13	11S	20E	MD	Produces miscellaneous stone and gold. Stone used in Friant Dam.
	Beziuk						See Quigley Kings River
75	Big Oak	J.E. Myers R. Vallandigham	6	11S	23E	MD	Produces tungsten
	Black Chief						See Chrome Gulch Nos. 1 and 3
43	Burkhart and Teaford	A.R. Burkhart and Otis Teaford, locators; Carl Secrest and Clyde F. Chelf, licensees	18	14S	11E	MD	Produces marl. Operated under name of Marlife Co., 814 Olive Ave., Fresno

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
22	California Coal	E.M. Einstein. In 1940 leased to M.J. Raney, Coalinga	22	20S	14E	MD	Produces coal. R 10:187; R 11:217-218; R 12:50-51; R 13:53; B 19:139. (Herein)
23	Carey Creek Coal		16	22S	14E	MD	R 12:51. (Herein)
	Carson						See Chrome Gulch Nos. 1 and 3
67	Central Rock & Sand Co.	Wallace C. McAllister, Box 428, Sanger	17	14S	23E	MD	Produces sand and gravel. B 142:181
34	Childers Feldspar & Silica	W.H. Childers, Auberry	23	9S	22E	MD	Produces feldspar. R 25:311; R 27:415. (Herein)
3	Chrome Gulch No. 1 (Black Chief; Carson)	C.E. Hull, et al	NE¼ NE¼ 23	12S	24E	MD	Produces chromite. B 134, pt. III:90
4	Chrome Gulch No. 3 (Big Chief; Carson)	C.E. Hull, et al.	NW¼ NW¼ 24	12S	24E	MD	Produces chromite. B 134:pt. III:90
5	Clara H.	Spear & Loffinger	SE¼ NW¼ 25	11S	25E	MD	Produces chromite. B 134, pt. III:83. Produced 6,650 tons. Some ore in caved workings. (Herein)
68	Clingan Flagstone	W.M. Clingan et al Star Route, Orange Cove	26	13S	26E	MD	(Herein)
76	Clingan Scheelite	W.M. Clingan et al, Star Route, Orange Cove	NW¼	13S	26E	MD	Produces tungsten. (Herein)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
62	Coalinga Mineral Springs (Fresno Hot Springs)	Coalinga Mineral Springs, Inc., P.O. Box 307, Coalinga. Robt. L. Abell, Mgr.	34	20S	13E	MD	Produces mineral water. R 10:189; R 12:333; R 13:510; R 14:456; R 25: 319-320. (Herein)
27	Copper King (Hart)	John Davis, Sanger	3	12S	23E	MD	Produces copper. R 8:209; R 10:194; R 11: 217; R 12:66; R 13: 58-59; R 14:436-438; B 23:224-233; B 50:277-289; R 25:308-309; B 144:233; Univ. Calif., Dept. Geol. Sci., Bull. 26:268. (Herein)
21	Craycroft Brick Co.	Mrs. F.J. Craycroft pres., Belmont & Lafayette Sts., Fresno	1	14S	19E	MD	Produces brick and clay. R 14:433-434; B 38: 242; B 99:78; R 25:307. (Herein)
50	Crisle	John Crisle, Sanger	15	12S	24E	MD	Produces manganese. Rhodonite. B 152:53; B 125:112
	Croxon						See Mercy
	Defense						See Qualls
57	Del Mexico (Mexican; DeMexico)	C. Perez, Mendota	22	18S	13E	MD	Produces mercury. R 35:377; USGS Bull. 603: 207. (Herein)
24	Del Monte (Drabble)		26	20S	12E	MD	Produces coal. R 13:53. (Herein)
	De Mexico						See Del Mexico.

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
77	Dinkey Creek (Sadler; Lobos)	Tungstore Mine, Inc.	SW$\frac{1}{4}$ 21	10S	26E	MD	Produces tungsten. Krauskopf, USGS unpubl. manuscript
78	Dixie Queen	D.O. Whitt	SW$\frac{1}{4}$3	14S	26E	MD	Produces tungsten.
	Drabble						See Del Monte
	Drake Lime Co.					MD	Produces marl. Near Minkler (Herein)
79	Emerald Peak	John W. Riffe	NW$\frac{1}{4}$11	9S	29E	MD	Produces tungsten.
	Ferguson						See Sample
	Fort Miller Pumice & Pumicite	McKenzie Estate, Fresno		11S	21E	MD	Produces pumice and pumicite. Deposit covered by Friant Dam, but pumice stock-piled above high water. (Herein)
48	Fresno (Bachler; Piedra Magnesite Co.)		5	13S	24E	MD	Produces magnesite.
28	Fresno Copper (Heiskell)	John Parks, Los Angeles	10	12S	21E	MD	Produces copper. B 142:233; Univ. Calif. Sci, Bull. 26:268-269. (Herein)
69	Fresno County Granite Pit	Fresno County	18	11S	21E	MD	Produces miscellaneous stone.
	Fresno Hot Springs						See Coalinga Mineral Springs
	Garnet						See Qualls

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
80	Garnet Dike	Sheridan & Bennett, Tollhouse	NW$\frac{1}{4}$ 22	12S	27E	MD	Produces tungsten. B 142:190. Idle 1949, litigation (Herein)
39	Griffin (Paoli mine)	John K. Griffin, 270 Upland Dr., San Francisco	1 6	16S 16S	12E 13E	MD	Produces gypsum. R 25:317. (Herein)
51	Harper	W.J. Harper, Watts Valley	NW$\frac{1}{4}$33	11S	24E	MD	Produces manganese. Rhodonite and spessartite. B 152:53-54; B 125:112. (Herein)
	Hart						See Copper King.
	Heiskell						See Fresno Copper
	Herndon Rock Products						See Stewart and Nuss, Inc.
	Home Front						See Humphreys
81	Houghton Bros. (Kings River)	J.B., E.C., and R.J. Houghton	E$\frac{1}{2}$3	12S	26E	MD	Produces tungsten. (Herein)
82	Humphreys (Home Front)	J.W. Humphreys	NE$\frac{1}{4}$1	11S	23E	MD	Produces tungsten.
33	Insulator	A.P. Shepard (1935)	8	15S	12E	MD	Produces diatomite. R 25, 309. (Herein)
83	Jack Pot	R. Barnes, R. George, G.S. Peterson, A.E. Rothgarn	SE$\frac{1}{4}$9	11S	24E	MD	Produces tungsten. (Herein)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
39	Jack Sprat No. 1	C.E. Hull, et al	S$\frac{1}{2}$ SW$\frac{1}{4}$10	12S	24E	MD	Produces chromite. B 134, pt. III:87. Fair prospect for milling ore.
7	Jensen No. 4	C.E. Hull, et al.	NW$\frac{1}{4}$ NE$\frac{1}{4}$ 23	12S	24E	MD	Produces chromite. B 134, pt. III:36. Worked out.
	Kings River						See Quigley Kings River and Houghton Bros.
	Kings River, South Fork		appr. 6,11	13S	29E	MD	Produces tungsten. (Herein)
	Kneiper						See Neiper
58	Koski	J.M. Koski, Rt. 1, Box 3, Brush Prairie, Wash.	34	18S	13E	MD	Produces mercury. Prospect. (Herein)
8	Lacey	Eloise Edwards	NW$\frac{1}{4}$ NW$\frac{1}{4}$ 25	11S	23E	MD	Produces chromite. B 134, pt. III: 78-79. Produced more than 3,300 tons. (Herein)
40	Little Panoche	Agricultural Mineral & Fertilizer Co., A.D. Sousa, P.O. Box 832, Los Banos	1	14S	10E	MD	Produces gypsum. (Herein)
	Lobo						See Dinkey Creek

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
9	Long Ledge No. 1	C.E. Hull, et al	SE$\frac{1}{4}$ NE$\frac{1}{4}$24	12S	24E	MD	Produces chromite. B 134, pt. III:91-93
10	Long Ledge No. 2	C.E. Hull, et al	NW$\frac{1}{4}$ SW$\frac{1}{4}$19	12S	25E	MD	Produces chromite. B 134, pt. III:93
11	Long Ledge No. 3	C.E. Hull, et al	S$\frac{1}{2}$ SW$\frac{1}{4}$19	12S	25E	MD	Produces chromite. B 134, pt. III:95
35	Low Pocket	T. Pierson, Berkeley	27,28	12S	25E	MD	Produces gold. R 25:312
84	Lucky Clover Tungsten (Traweek)	Sam Davis, Bar 7 Ranch	29	13S	26E	MD	Produces tungsten. (Herein)
85	McBride Tungsten (Balch)	C.McBride	SW$\frac{1}{4}$11	12S	26E	MD	Produces tungsten.
	McKinsey						See Painted (?)
12	McMurty	R.W. Weldon	SW$\frac{1}{4}$ SE$\frac{1}{4}$4	12S	24E	MD	Produces chromite. B 134, pt. III:85-86. May be some reserves
52	McMurty	W.F. McMurty, Watts Valley	33	11S	24E	MD	Produces manganese. Rhodonite. B 152:54; B 125:112
63	Mercey Hot Springs	Lessee: Crooks & Ustick, Box 337, Dos Palos, H.C. Swatzel, Mgr.	15	14S	10E	MD	Produces mineral water. R 35:377-378; USGS Bull. 603:212-213. (Herein)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
59	Mercey (Mercy; Pacific Providential; Arambide; Aurecoechea; Croxon)	S.M. Biaggi, San Jose	32,33	13S	10E	MD	Produces mercury. R 35:377-378; B 78:44-46; USGS Bull. 603:207. (Herein)
	Mercy						See Mercey
	Mexican						See Del Mexico
44	Montford marl		24	21S	14E	MD	Produces marl. (Herein)
64	Mother Green's Spring	Mrs. Ida Green, 1006 No. 11th St., Fresno	24	20S	12E	MD	Produces mineral water. (Herein)
	Mount Campbell Lime						Produces marl. Near Reedley. Operated 1937-39. (Herein)
86	Mud Lakes	Tungstore Mines, Inc.	36 30,31	9S 9S	26E 27E	MD	Produces tungsten.
	Myers	C.J. Myers	7	11S	23E	MD	Produces tungsten. Location questionable.
29	Nieper (Knieper)		34	11S	23E	MD	Produces copper. R 10:94. Produced prior to 1890. (Herein)
	Pacific						See Mercey
70	Pacific Coast Aggregates, Inc.	400 Alabama St., San Francisco	36	11S	20E	MD	Produces miscellaneous stone and gold. B.142: 159, 181. (Herein)
30	Painter (McKinsey?)	Imperial Copper Co., Clovis (1917)	33	11S	21E	MD	Produces copper. R 14:438 (Herein)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
41	Panoche No. 1 and No. 2		30	14S	12E	MD	Produces gypsum.
13	Perry	Bernice and F.M. Perry	NE$\frac{1}{4}$24	11S	23E	MD	Produces chromite. B 134, pt. III:77
49	Piedra (Ward)		9	13S	24E	MD	Produces magnesite.
	Piedra Magnesite Co.						See Fresno
31	Post Oak	W. Stammers, Selma (1934)	29	12S	25E	MD	Produces copper. R 25:312; R 13:169. (Herein)
	Powers	G. Hannemann and B. Hammel	E$\frac{1}{2}$(?) 24	11S	23E	MD	Produces chromite. Location uncertain. Probably mined out. B 134, pt. III:101
53	Price	J.W. Price, Trimmer	11	12S	24E	MD	Produces manganese. Rhodonite. B 152:54-55; B 125:112
	Providential						See Mercey
87	Qualls (Garnet Defense)	Wes Qualls	NW$\frac{1}{4}$13	9S	26E	MD	Produces tungsten.
88	Quigley	Clarence Quigley, Trimmer Route, Sanger	SE$\frac{1}{4}$21	12S	27E	MD	Produces tungsten. Near Garnet Dike.

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
89	Quigley (Kings River; Baziuk, Beziuk)	Kings River Mines (1944)	NE$\frac{1}{4}$22	12S	27E	MD	Produces tungsten. (Herein)
90	Rabbit's Foot (Reiss)	J.A. and Marguerite Reiss, 3635 Kerckhoff, Fresno	SW$\frac{1}{4}$7	11S	25E	MD	Produced tungsten. (Herein)
91	Red Bud Tungsten and Limestone (Adrian Alexander; Spanish Peak)	Spencer Estate, owner; Al Feuerstein, 3863 Kerckhoff, Fresno, lessee	SE$\frac{1}{4}$15	11S	24E	MD	Produces tungsten. R 39:53-54. Produced tungsten 1943-44 and limestone 1948. (Herein)
14	Red Slide No. 2	C.E. Hull, et al	SE$\frac{1}{4}$ NE$\frac{1}{4}$23	12S	24E	MD	Produces chromite. B 134, pt. III:90-91
	Reiss						See Rabbit's Foot
	Rita						See Anita
71	River View Rock Co.	Pollard Bros., Ltd. Fresno	27	12S	19E	MD	Produces sand and gravel. (Herein)
15	Rock Wren	H.S. Coyle and H. Strassbaugh	NW$\frac{1}{4}$ NW$\frac{1}{4}$24	11S	23E	MD	Produces chromite. B 134, pt. III:76
1	Ross-Garcia Asbestos	R. Moon, Hanford, et al	21	19S	13E	MD	Produces asbestos. Prospects. (Herein)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
60	Ruth Hill		12	14S	25E	MD	Produces mica. (Herein)
16	Saddle Blanket No. 1	C.E. Hull, et al	SW$\frac{1}{4}$ NE$\frac{1}{4}$15	12S	24E	MD	Produces chromite. B 134, pt. III:89
17	Saddle Blanket No. 2	C.E. Hull, et al	NW$\frac{1}{4}$ SW$\frac{1}{4}$14	12S	24E	MD	Produces chromite. B 134, pt. III:89
18	Saddle Blanket No. 3	C.E. Hull, et al	NW$\frac{1}{4}$ SW$\frac{1}{4}$14	12S	24E	MD	Produces chromite. B 134, pt. III:89
	Sadler						See Dinkey Creek
	Sadler	Joe Sadler	19	9S	27E	MD	Produces tungsten. Location questionable.
	Sadler	Joe Sadler	19	10S	26E	MD	Produces tungsten. Location questionable.
19	Saint	R.E. Saint	NW$\frac{1}{4}$ SE$\frac{1}{4}$25	11S	23E	MD	Produces chromite. B 134, pt. III, p. 84. Worked out.
	Sample (Ferguson)						Produces magnesite. On Holland Creek, south of Academy.
45	San Joaquin Marble Co.	A. Emory Wishon, et al., Fresno (1929)	36	8S	24E	MD	Produces limestone. R 25:317-318. (Herein)
25	San Joaquin Valley		26	20S	14E	MD	Produces coal. R 13:305 (Herein)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Santa Reta						See Anita
46	Secrest	C.M. Secrest, 2015 Mariposa St., Fresno	11	14S	23E	MD	Produces marl. Operated 1931-36 by Coral Reef Lime Products Co. (Herein)
	Sharp & Fellow Construction Co.	533 Central Bldg., San Francisco					Produces crushed rock. B 142:181
	Southern California Edison Co.	Edison Bldg., Los Angeles					Produces sand and gravel. B 142:181
	Spanish Peak						See Red Bud
	Spence	P.D. Spence	16	11S	24E	MD	Produces tungsten. Location questionable.
72	Stewart and Nuss, Inc. (Herndon Rock Products Co.)	Stewart and Nuss, Inc., 410 Thorne St., Fresno	25 31,32	12S	19E	MD	Produces miscellaneous stone and gold. B 142:181 (Herein)
	Sunset and Sunrise	V.R. Smith (G.E. Freme, former lessee)					Produces manganese. B 125:77,112. B 152:55; B 125:112. (Herein) Alcalde district
37	Superior-Academy Granite Co.	Superior Academy Granite Co., Box 68 Clovis	13	12S	22E	MD	Produces granite. R 25:314-315. (Herein)
92	Terrill	L.G. Maxon	NW¼7	12S	25E	MD	Produces tungsten

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
20	Thelma No. 1	C.E. Hull, et al	NW$\frac{1}{4}$ SW$\frac{1}{4}$24	12S	24E	MD	Produces chromite. B 134, pt. III:91
73	Thompson Materials & Construction Co., Inc	Avenal	27,34	21S	16E	MD	Produces sand and gravel. B 142:181. (Herein)
93	Three Buddies	Louis Kientz, Harry Shoepf, Fred Kasson	NW$\frac{1}{4}$1	11S	23E	MD	Produces tungsten.
	Tivy Valley Granite	C.W. Turnage & Son 1218 Q St., Sanger	appr. 24	13S	23E	MD	Produces miscellaneous stone. (Herein)
	Traweek						See Lucky Clover Tungsten
54	Trewick-Houghton	C.C. Trewick, Dunlap	SW$\frac{1}{4}$29	13S	26E	MD	Produces manganese. Rhodonite. B 152:55; B 125:112
47	Twin Lakes		29,30	7S	26E	MD	Produces limestone. (Herein)
32	Uncle Sam		2,3	12S	29E	MD	Produces copper. R 14:438. (Herein)
42	Valley View Gypsum	R.P. Jones, Madera	19	14S	12E	MD	Produces gypsum. (Herein)
	Ward						See Piedra
26	Warthan Creek		12	21S	13E	MD	Produces coal. R 12:54. (Herein)
	Webb and Mingus	Webb and Mingus, Coalinga		18S	12E	MD	Produces asbestos. R 25:306

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
94	We Hope	Ralph E. Carver, J.J. Brooks	NW¼22	10S	26E	MD	Produces tungsten.
36	White Cross, Dixie Queen and King Poultice	J.G. and D.O. Whitt Dunlap	3,4	14S	26E	MD	Produces gold. R 25:313-314
	Woods	"Jake" Rice, Pine Flat		12S	24E	MD	Produces manganese. Near Piedra. Rhodonite. B 152:56

DIVISION OF MINES
OLAF P. JENKINS, CHIEF

STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES

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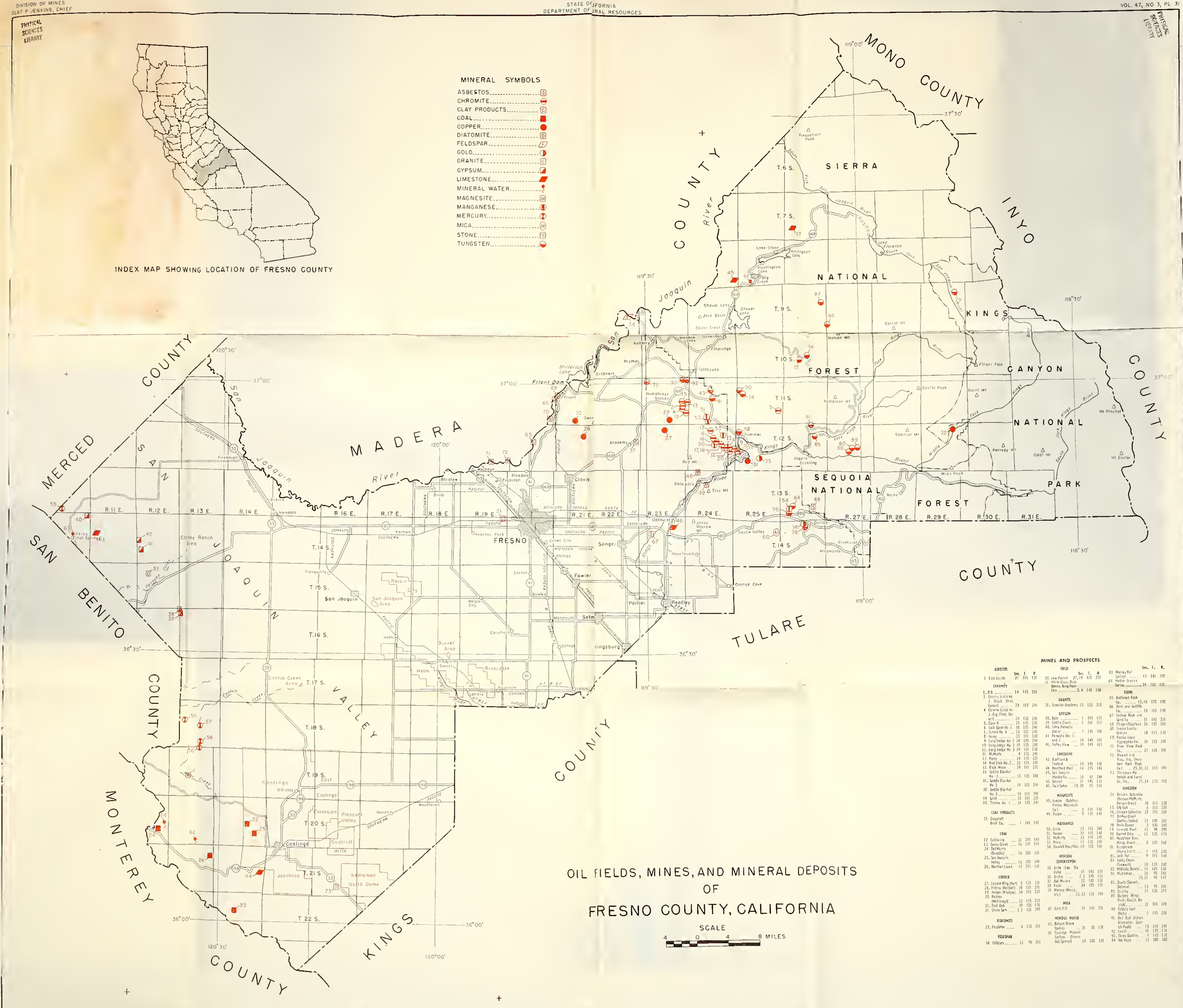
INDEX MAP SHOWING LOCATION OF FRESNO COUNTY
MINERAL SYMBOLS
ASBESTOS
CHROMITE
CLAY PRODUCTS
COAL
COPPER
DIATOMITE
FELDSPAR
GOLD
GRANITE
GYPSUM
LIMESTONE
MINERAL WATER
MAGNESITE
MANGANESE
MERCURY
MICA
STONE
TUNGSTEN
MONO COUNTY
MADERA COUNTY
INYO COUNTY
TULARE COUNTY
KINGS COUNTY
MONTEREY COUNTY
SAN BENITO
MERCED
SIERRA NATIONAL FOREST
KINGS CANYON NATIONAL PARK
SEQUOIA NATIONAL FOREST
SAN JOAQUIN VALLEY
FRESNO
Clovis
Sanger
Fowler
Selma
Kingsburg
Reedley
Parlier
Coalinga
Huron
Mendota
Kerman
Firebaugh
Orange Cove
Friant Dam
Millerton Lake
San Joaquin River
Kings River
T. 6 S.
T. 7 S.
T. 9 S.
T. 10 S.
T. 11 S.
T. 12 S.
T. 13 S.
T. 14 S.
T. 15 S.
T. 16 S.
T. 17 S.
T. 18 S.
T. 19 S.
T. 20 S.
T. 21 S.
T. 22 S.
R. 11 E.
R. 12 E.
R. 13 E.
R. 14 E.
R. 16 E.
R. 17 E.
R. 18 E.
R. 19 E.
R. 21 E.
R. 22 E.
R. 23 E.
R. 24 E.
R. 25 E.
R. 27 E.
R. 28 E.
R. 29 E.
R. 30 E.
R. 31 E.
119°00'
119°30'
120°00'
120°30'
118°30'
37°00'
37°30'
36°30'
36°00'
SCALE
4 0 4 8 MILES

OIL FIELDS, MINES, AND MINERAL DEPOSITS OF FRESNO COUNTY, CALIFORNIA

MINES AND PROSPECTS

	Sec.	T.	R.
ASBESTOS			
1. Ross Garcia	21	19S	13E
CHROMITE			
2. B B	14	11S	23E
3. Chrome Gulch No. 1 (Black Chief, Carson)	23	11S	24E
4. Chrome Gulch No. 3 (Big Chief; Carson)	24	12S	24E
5. Clara M.	25	11S	25E
6. Jack Sprat No. 1	10	12S	24E
7. Jensen No. 4	23	12S	24E
8. Jersey	25	11S	13E
9. Long Ledge No. 1	24	12S	24E
10. Long Ledge No. 2	19	12S	25E
11. Long Ledge No. 3	19	12S	15E
12. McMurty	4	12S	24E
13. Perry	24	11S	23E
14. Red Slide No. 2	23	12S	24E
15. Rock Wren	28	11S	23E
16. Saddle Blanket No. 1	15	12S	24E
17. Saddle Blanket No. 2	14	12S	24E
18. Saddle Blanket No. 3	14	11S	24E
19. Sutol	25	11S	23E
20. Thelma No. 1	24	12S	24E
CLAY PRODUCTS			
21. Graycroft Brick Co.	1	14S	19E
COAL			
22. California	22	20S	14E
23. Carey Creek	16	22S	14E
24. Del Monte (Drebble)	16	20S	12E
25. San Joaquin Valley	16	20S	14E
26. Warthan Creek	12	21S	13E
COPPER			
27. Copper King (Hart)	3	12S	23E
28. Fresno (Mitchell)	10	12S	21E
29. Kelper (Knelper)	34	11S	23E
30. Painter (McKinsey)	33	11S	21E
31. Red Oak	29	12S	15E
32. Uncle Sam	2, 3	12S	29E
DIATOMITE			
33. Insulator	8	15S	11E
FELDSPAR			
34. Childers	23	9S	21E
GOLD			
35. Lost Pocket	27, 28	12S	25E
36. White Cross, Dixie Queen, King [illegible]	3, 4	14S	16E
GRANITE			
37. Superior-Academy	13	12S	22E
GYPSUM			
38. Baker	1	16S	12E
39. Griffin (Paoli)	1	16S	11E
40. Little Panoche placer	1	14S	10E
41. Panoche Nos. 1 and 2	30	14S	11E
42. Valley View	19	14S	12E
LIMESTONE			
43. Barthart & Tealord	18	14S	11E
44. Montford Marl	14	21S	14E
45. San Joaquin Marble Co.	36	8S	24E
46. Secrest	11	14S	13E
47. Twin Lakes	29, 30	7S	26E
MAGNESITE			
48. Fresno (Butcher; Piedra Magnesite Co.)	5	13S	24E
49. Piedra	9	13S	24E
MANGANESE			
50. Crisle	15	11S	24E
51. Harper	31	11S	24E
52. McMurty	33	11S	24E
53. Price	11	12S	24E
54. Trewick Hoc[illegible]	19	13S	26E
MERCURY (QUICKSILVER)			
55. Aurita (Ida, Sta Rita)	11	18S	13E
56. Archer	2, 3	19S	13E
57. Del Monte	22	18S	13E
58. Rashi	34	18S	13E
59. Mercer (Mercy, etc.)	32, 33	13S	10E
MICA			
60. Rush Hill	11	14S	25E
MINERAL WATER			
61. Balsam Green Springs	31	8S	25E
62. Coalinga Mineral Springs (Fresno Hot Springs)	34	20S	13E
63. Mercey Hot Springs	15	14S	10E
64. Malbin Greene Spring	24	20S	12E
STONE			
65. Anderson Rock Co.	15, 16	12S	20E
66. Best and Griffith Co.	13	11S	20E
67. Central Rock and Sand Co.	11	14S	23E
68. Clingan Flagstone	26	13S	26E
69. Fresno County Granite	18	11S	21E
70. Pacific Coast Aggregates Inc.	36	11S	20E
71. River View Rock Co.	27	12S	19E
72. Stewart and Nuss, Inc. (Herndon Rock Prod. Co.)	25, 31, 32	11S	19E
73. Thompson Materials and Const. Co., Inc.	27, 34	21S	15E
TUNGSTEN			
74. Benson Scheelite (Benson-McMurty; Benson Bros.)	18	11S	25E
75. Big Oak	6	11S	23E
76. Clingan Scheelite	32	13S	26E
77. Dinkey Creek (Dudley; Lobos)	21	10S	26E
78. Dixie Queen	3	14S	26E
79. Emerald Peak	11	9S	29E
80. Garnet Dike	12	12S	27E
81. Hoagland Bros. (Kings River)	3	12S	26E
82. Humphreys (Home [illegible])	1	11S	23E
83. Jack Pot	9	11S	24E
84. Lucky Clover (Tremcel)	29	13S	26E
85. McBride (Baker)	11	12S	26E
86. Mud Lakes	36	9S	26E
	30, 31	9S	27E
87. Quails (Garnet Defense)	13	9S	26E
88. Quigley	21	12S	27E
89. Quigley (Kings River; Basin, Bedell)	21	11S	27E
90. Rabbit Foot (Ross)	1	11S	25E
91. Red Bud (Adrian Alexander; Spanish Peak)	15	11S	24E
92. Terrill	4	12S	25E
93. Three Buddies	1	11S	23E
94. We Hope	22	10S	26E

STATE OF CALIFORNIA
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DEPARTMENT OF NATURAL RESOURCES
WARREN T. HANNUM, Director

DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO 11
OLAF P. JENKINS, Chief

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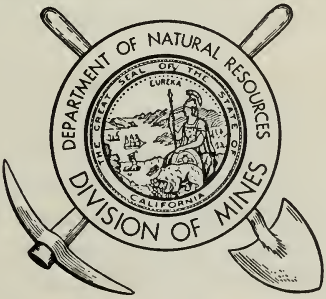

STATE OF CALIFORNIA
EARL WARREN, Governor
DEPARTMENT OF NATURAL RESOURCES
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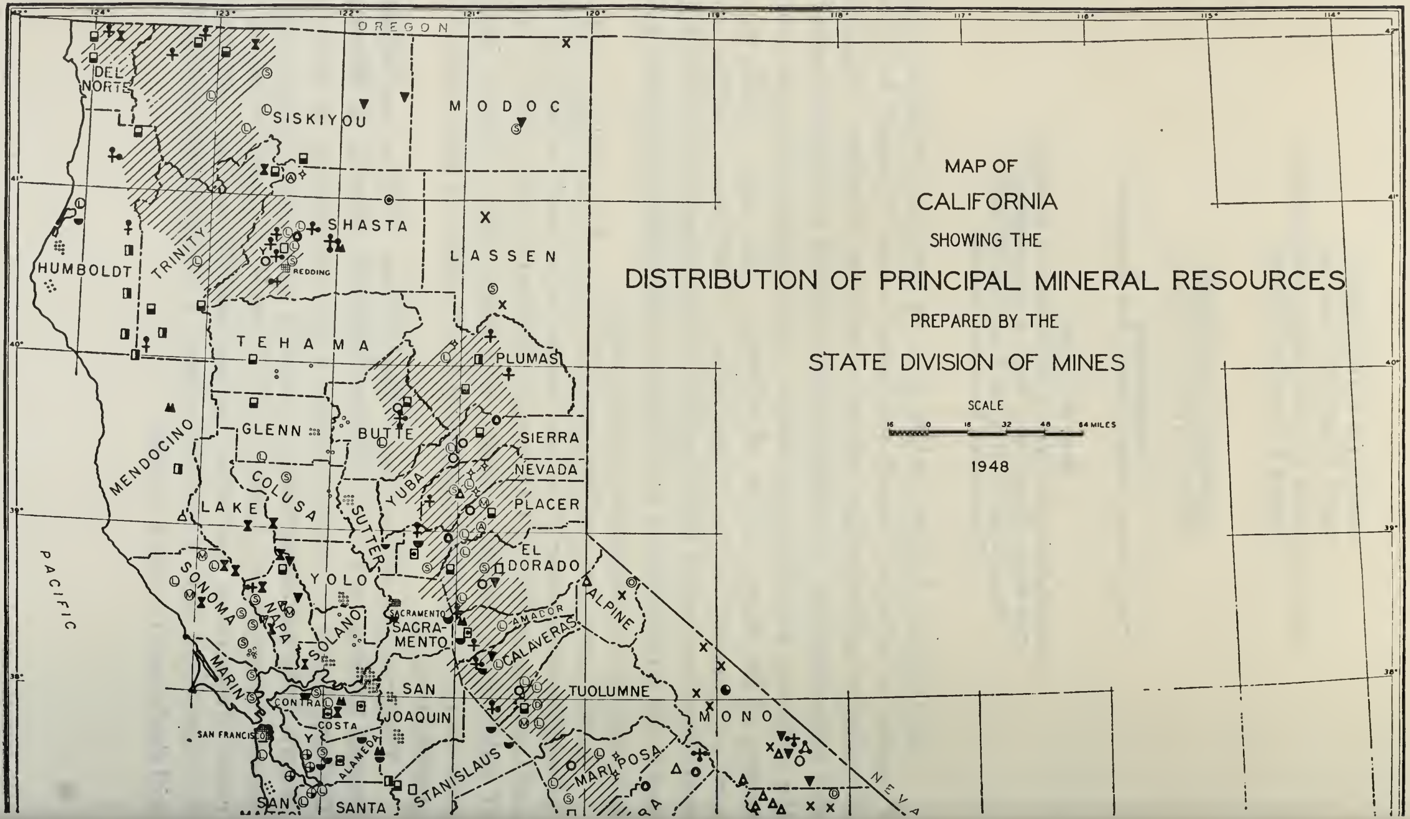
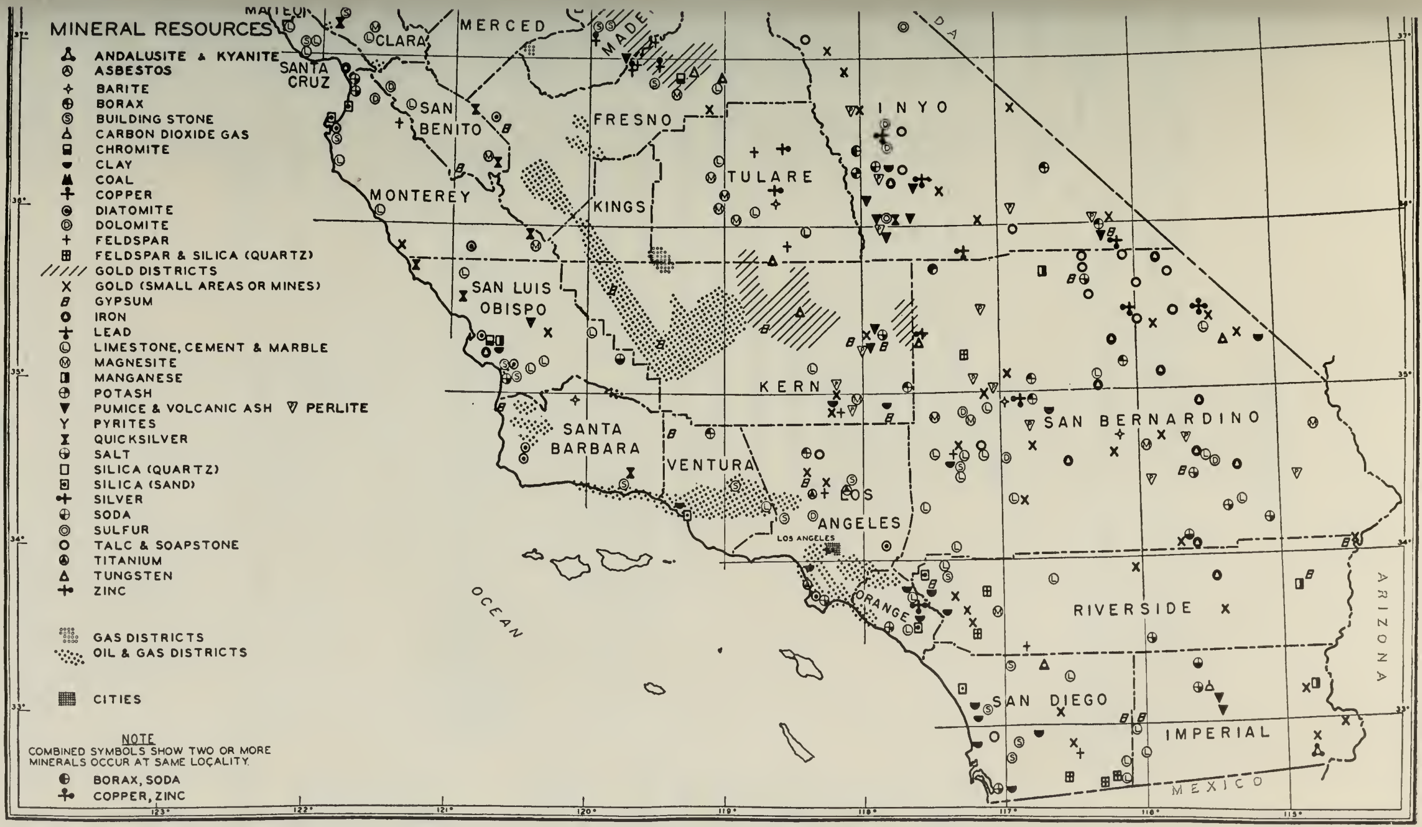
In addition to oral conferences in the offices of the Division of Mines, information concerning the mineral resources, mineral industry, geology, and mining operations of California is distributed to the public by means of publications, monthly releases, and letters. Each letter of inquiry received by the Division is answered by the technical staff member best qualified to do so.

The principal publications of the Division of Mines are **Bulletins**, **Special Reports**, and the quarterly **California Journal of Mines and Geology**, issued in January, April, July, and October of each year. **Mineral Information Service** is a monthly news release concerning the mineral resources and industry of California, designed to inform the public of discoveries, operations, markets, statistics, and new publications. It is distributed without cost upon request. A list of available publications will also be sent free upon request.


MAP OF
CALIFORNIA
SHOWING THE
DISTRIBUTION OF PRINCIPAL MINERAL RESOURCES
PREPARED BY THE
STATE DIVISION OF MINES

SCALE
16
0
16
32
48
64 MILES
1948
OREGON
PACIFIC
NEVA
124°
123°
122°
121°
120°
119°
118°
117°
116°
115°
114°
42°
41°
40°
39°
38°
DEL NORTE
SISKIYOU
MODOC
HUMBOLDT
TRINITY
SHASTA
REDDING
LASSEN
TEHAMA
PLUMAS
GLENN
BUTTE
SIERRA
NEVADA
MENDOCINO
COLUSA
YUBA
PLACER
LAKE
SUTTER
EL DORADO
SONOMA
YOLO
NAPA
SACRAMENTO
SACRA-MENTO
AMADOR
ALPINE
SOLANO
CALAVERAS
MARIN
SAN JOAQUIN
TUOLUMNE
MONO
CONTRA COSTA
SAN FRANCISCO
ALAMEDA
STANISLAUS
MARIPOSA
SAN MATEO
SANTA


MINERAL RESOURCES
ANDALUSITE & KYANITE
ASBESTOS
BARITE
BORAX
BUILDING STONE
CARBON DIOXIDE GAS
CHROMITE
CLAY
COAL
COPPER
DIATOMITE
DOLOMITE
FELDSPAR
FELDSPAR & SILICA (QUARTZ)
GOLD DISTRICTS
GOLD (SMALL AREAS OR MINES)
GYPSUM
IRON
LEAD
LIMESTONE, CEMENT & MARBLE
MAGNESITE
MANGANESE
POTASH
PUMICE & VOLCANIC ASH
PERLITE
PYRITES
QUICKSILVER
SALT
SILICA (QUARTZ)
SILICA (SAND)
SILVER
SODA
SULFUR
TALC & SOAPSTONE
TITANIUM
TUNGSTEN
ZINC
GAS DISTRICTS
OIL & GAS DISTRICTS
CITIES
NOTE
COMBINED SYMBOLS SHOW TWO OR MORE MINERALS OCCUR AT SAME LOCALITY.
BORAX, SODA
COPPER, ZINC
MERCED
MADERA
SANTA CRUZ
CLARA
SAN BENITO
MONTEREY
FRESNO
KINGS
TULARE
INYO
SAN LUIS OBISPO
KERN
SANTA BARBARA
VENTURA
LOS ANGELES
SAN BERNARDINO
RIVERSIDE
ORANGE
SAN DIEGO
IMPERIAL
ARIZONA
MEXICO
OCEAN
37°
36°
35°
34°
33°
123°
122°
121°
120°
119°
118°
117°
116°
115°

CONTENTS

Page

Mines and Mineral Resources of Contra Costa County, by Fenelon F. Davis and James W. Vernon ---------- 561

Fluorspar in California, by James W. Crosby III and Samuel R. Hoffman ---------- 619

Index to Volume 47 ---------- 639

PLATES

Page

Plate 32. Photo of catalytic cracking tower ---------- 584–585

33. Photo of rock quarry and plant at Upton ---------- 584–585

34. Photo of landslide near Port Chicago ---------- 584–585

35. Photo of Mount Diablo quicksilver mine ---------- 584–585

36. Photo of Eocene sandstone stratum ---------- 584–585

37. Photo of Longwell Ranch sand pits ---------- 584–585

38. Photo of lubricant dewaxing plant ---------- 584–585

39. Photo of field kilns at Port Costa Brick Works ---------- 584–585

40. Summary of economic geology of Contra Costa County ---------- In pocket

41. *A*, Aerial view southwest down the shore of San Pablo Bay. *B*, Aerial view north across Point San Pablo ---------- In pocket

42. Map of Contra Costa County showing mineral resources ---------- In pocket

43. *A*, Photomicrograph of ore from area northwest of Korfist shaft. *B*, Photomicrograph of ore from area northwest of Korfist shaft. *C*, Photomicrograph of ore from Korfist's main incline. *D*, Photomicrograph of ore from the Douglass No. 1 property ---------- 632–633

44. Vein fluorspar from the Big Horn No. 9 claim ---------- 632–633

45. Fluorspar in andesite breccia ---------- 632–633

46. Fluorspar from the White Mountains deposit, Inyo County ---------- 632–633

47. Geologic map of a part of Clark Mountain showing occurrences of fluorspar ---------- In pocket

MINES AND MINERAL RESOURCES OF CONTRA COSTA COUNTY

BY FENELON F. DAVIS * AND JAMES W. VERNON **

OUTLINE OF REPORT

Page
Abstract ---- 562
Introduction ---- 563
Mines and mineral resources ---- 566
  Metallic and nonmetallic mineral commodities ---- 567
    Asbestos ---- 567
    Cement ---- 567
    Chromite ---- 571
    Clay ---- 572
    Copper ---- 573
    Diatomite ---- 573
    Gold ---- 574
    Limestone ---- 574
    Manganese ---- 575
    Mercury (quicksilver) ---- 575
    Mineral water ---- 576
    Pumice ---- 577
    Sand—aggregate ---- 579
    Sand—foundry and glass ---- 580
    Stone ---- 584
  Mineral fuels ---- 588
    Asphalt ---- 588
    Coal ---- 588
    Natural gas and petroleum ---- 591
    Peat ---- 592
Mineral processing industry ---- 594
  Metallic ores ---- 594
  Mineral wool ---- 597
  Perlite ---- 598
  Petroleum refining ---- 598
  Pyrite ---- 603
  Refractories ---- 603
Tabulated list of Contra Costa County mineral deposits ---- 604
Bibliography ---- 615

Illustrations

Page
Figure 1. Flow sheet, Roberts Sand Company, Pittsburg Plant ---- 582
2. Section through the Black Diamond shaft of the Black Diamond coal mine ---- 589
3. Flow sheet, Selby Lead Smelter, American Smelting and Refining Company ---- 595
4. What comes out of a barrel of crude ---- 599
5. Flow chart—from crude oil to modern life ---- 601
Plate 32. Photo of catalytic cracking tower ---- 584–585
33. Photo of rock quarry and plant at Upton ---- 584–585
34. Photo of landslide near Port Chicago ---- 584–585
35. Photo of Mount Diablo quicksilver mine ---- 584–585
36. Photo of Eocene sandstone stratum ---- 584–585
37. Photo of Longwell Ranch sand pits ---- 584–585
38. Photo of lubricant dewaxing plant ---- 584–585
39. Photo of field kilns at Port Costa Brick Works ---- 584–585
40. Summary of economic geology of Contra Costa County ---- In pocket
41. *A*, Aerial view southwest down the shore of San Pablo Bay. *B*, Aerial view north across Point San Pablo ---- In pocket
42. Map of Contra Costa County showing mineral resources ---- In pocket

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ABSTRACT

Contra Costa County, in the Coast Ranges of central California, lies northeast of San Francisco and Oakland and is in the San Francisco Bay area. Its 734 square miles include such topographic extremes as delta and tidal flats along San Francisco Bay and adjoining waters, and Mount Diablo rising to 3,849 feet above sea level near the center of the county. Rocks typical of the central Coast Ranges, ranging in age from Upper Jurassic to Recent are exposed in the county. On the flanks of Mount Diablo, exceptionally thick sections of Cretaceous and Tertiary rocks are exposed. Mount Diablo consists of a plug of Franciscan (Upper Jurassic) ultrabasic and metamorphic rocks which has been thrust upward into the overlying Cretaceous rocks. The Cretaceous and Tertiary strata of the county have been compressed into a series of northwest-trending folds well exposed in the Mount Diablo area, and in the hills between Mount Diablo and San Francisco Bay.

The value of the total recorded mineral production for the county, 1894-1949, is $81,612,511. During 1949, mineral production was valued at $1,249,973, ranking the county thirtieth among California's 58 counties. Contra Costa County ranked fifteenth in 1943, the year of peak production, when minerals valued at $4,284,821 were produced. The mineral commodities produced during 1949 were clay, natural gas, sand, and stone. Mineral water has been sold continuously for many years, but production figures are no longer available. In the past, substantial quantities of cement, coal, and mercury were marketed. Small amounts of agricultural peat, and pumice have been sold in recent years.

Stone quarries in Contra Costa County have for many years supplied crushed rock, riprap, and fill material for the construction industries of the east bay area. Four quarries and rock plants were operating during 1949 and 1950. The materials processed in these plants are: sandstone from the Franciscan group (Upper Jurassic), basalt from the Moraga formation (Pliocene), and sandstone from the Monterey group (Miocene).

Mineral water is produced at two localities in the county, near Orinda and south of Martinez.

Henry Cowell Lime and Cement Company operated a cement plant southeast of Concord from 1909 to 1946, using travertine-limestone and clay mined on nearby Lime Ridge. The plant was closed when the limestone deposits were depleted.

An estimated 3,500,000 tons of sub-bituminous coal was mined from the Domengine formation (Eocene) in the northern foothills of Mount Diablo before the mines were closed in 1902. Competition from petroleum products forced the cessation of coal mining.

Mercury production has been intermittent since about 1875, the Mount Diablo mine being the only producer. Total recorded production was 10,749 flasks, most of which was produced between 1938 and 1946. This deposit is associated with serpentine of the Franciscan group, and is unique in having metacinnabar as an abundant primary mineral.

Large quantities of clay shale, suitable for use in the manufacture of face and common brick and cement, have been mined from Jurassic, Cretaceous, and Tertiary strata. Virtually unlimited reserves of this type of material are available. Two brick plants have been operating continuously for many years using clay mined in the county.

Natural gas from Eocene sands underlying the northeastern part of the county is produced from seven wells, which tap the southern end of the productive structure of the Rio Vista gas field, the largest dry natural gas field in California.

Sand for use in asphalt plants is mined from sand dunes of Recent age, east of Antioch along the south bank of the San Joaquin River. Eocene sand cropping out on the northeast flank of Mount Diablo was mined for glass sand and clay-free foundry sand; and, in the past, large quantities were mined south of Brentwood for glass manufacturing.

An extensive mineral processing industry is centered in the county. Petroleum refining is the leading industry; refineries are at Richmond, Oleum, Martinez, and Associated. The only lead smelter on the Pacific Coast is operated at Selby by the American Smelting and Refining Company. Refractories are manufactured at Pittsburg from California clays. At Richmond, mineral wool is produced from copper slag; pyrite is roasted and the sulfur dioxide gas is recovered for the manufacture of sulfuric acid; and crude perlite is expanded for the plaster industry.

INTRODUCTION

Contra Costa County, in the Coast Ranges of central California, is an east bay county touching tidewater of northern San Francisco Bay (with its contiguous waters of San Pablo Bay, Carquinez Strait, and Suisun Bay), and the delta waters of the Sacramento and San Joaquin Rivers. The county borders Berkeley and metropolitan Oakland on the northeast and is 15 miles from San Francisco by automobile via the San Francisco-Oakland Bay Bridge.

History. Contra Costa County was created on February 18, 1850, as one of the original 27 counties of the state. As first constituted it included most of Alameda County which was formed in 1853 from parts of Contra Costa and Santa Clara Counties. Only slight changes have been made in the county boundaries since that time. Contra Costa in Spanish means "opposite coast", a name applied to the eastern shore of San Francisco Bay by the early settlers of San Francisco. White men first entered the Contra Costa County area in 1772 when an expedition headed by a Spaniard, Pedro Fages, explored the county searching for a land route to Point Reyes [1].

The first orchards and vineyards were planted in 1823 near the present town of San Pablo; permanent dwellings were built shortly thereafter. The first white residents entered the area in the late 1830's.

Mineral production began about 1855 in Contra Costa County when coal was first mined from the Mount Diablo coal field in the northern foothills of Mount Diablo. Mercury was mined as early as 1875 at the Mount Diablo quicksilver mine (originally Ryne mine) on Mount Diablo. Table 4 records the history of mineral production from the county. Mineral industry activities since 1927 [2], the date of the last published report on the county, are emphasized in this report. Activities prior to 1927 are reviewed, the information being obtained mainly from the literature. Included in the present report are a tabulation of mineral deposits and a map showing their locations.

Geography and Topography. Contra Costa County contains 734 square miles which are bounded on the west and north by San Francisco Bay and adjoining waters, on the east by San Joaquin County, and on the south by Alameda County. The dominant topographic feature is Mount Diablo, 3849 feet high, covering about 15 square miles near the center of the county. Mount Diablo is flanked on three sides by areas of low relief: tidewater and delta land on the north, San Joaquin Valley on the east, and Livermore Valley on the south. The area west of Mount Diablo is occupied by hills having an average elevation of 1000 feet. A low ridge of hills runs southeastward from the base of Mount Diablo, separating San Joaquin and Livermore Valleys. About half of the county is cultivated, the remainder being mountainous grazing areas and urban areas. The largest continuous area of cultivation is the eastern quarter, which embraces part of the San Joaquin Valley and the reclaimed delta area of the San Joaquin River. An extensive area of cultivation also extends southeastward from Martinez into the area drained by Walnut and San Ramon Creeks, along the west side of Mount Diablo.

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[1] California Blue Book: Contra Costa County, p. 489, 1946.

[2] Laizure, C. McK, San Francisco field division—Contra Costa County: California Min. Bur. Rept. 23, pp. 2-31, 1927.

General Geology. Contra Costa County embraces parts of two geomorphic provinces. The western two-thirds of the county is in the Coast Ranges province, and the eastern one-third is in the Great Valley province [3].

The geology of the county has been studied in considerable detail; the principal published reports are by Lawson [4], Weaver [5], and Taff [6].

The general surface geology of the county is shown on the Geologic Map of California on a scale of approximately 1 inch to 8 miles [7].

Mount Diablo and the hills of the western part of the county constitute the northern end of the Diablo Range, which extends 170 miles southeastward, forming the west side of the San Joaquin Valley. The core of the range is composed of a distinctive assemblage of rocks of the Franciscan group of Upper Jurassic age. The principal rocks of this formation are hard arkosic sandstone, red chert, shale, basic volcanic rocks, and serpentine. They are exposed over thousands of square miles in the Coast Ranges, both north and south of Contra Costa County, and are believed to underlie younger rocks over a much larger area. The principal areas of Franciscan rocks in the Diablo range are along the crest of the range between central Alameda County and southern San Benito County. They are exposed at the surface over 15 square miles in the central part of Mount Diablo; on Potrero San Pablo west of Richmond; and on the western slope of the Oakland-Berkeley Hills, east of Richmond. Numerous small patches of Franciscan occur along the Contra Costa-Alameda County line just east of Oakland and Berkeley. The structure within the Franciscan masses is generally obscure. In many places Franciscan and later rocks are in contact along faults.

Post-Franciscan rocks in the county include a wide variety of marine and continental sediments of Cretaceous and Tertiary age, and Tertiary volcanic rocks. These rocks have been compressed into a series of northwest-trending folds, paralleling the general trend of folding in the Diablo Range and the entire Coast Range province. As elsewhere in the Coast Ranges, extensive faulting has accompanied the development of these structures. The largest fold in Contra Costa County is the Mount Diablo anticline. This fold extends from Tracy northward about 55 miles through Mount Diablo, and then across Carquinez Strait to a point north of Sulphur Springs Mountain. The anticline culminates at Mount Diablo. Here an unusual pluglike, igneous and metamorphic complex of Franciscan rocks, is upthrust through Cretaceous shale into the crest of the structure. In the Mount Diablo area not less than 43,000 feet of Jurassic, Cretaceous, and Tertiary strata are exposed, constituting one of the most complete stratigraphic sequences in the Coast Ranges. The system of smaller folds lying west of Mount Diablo is bounded on the west by the northwest-trending Hayward fault along the front of the Oakland-Berkeley Hills. The present elevation of the hilly area of western Contra Costa County is largely the result of uplift along the Hayward fault.

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[3] Jenkins, O. P., Geomorphic provinces of California: California Div. Mines Bull. 118, pp. 83-88, 1943.

[4] Lawson, A. C., U. S. Geol. Survey, Geol. Atlas, San Francisco folio (no. 193), 24 pp., 1914.

[5] Weaver, C. E., Geology and mineral deposits of an area north of San Francisco Bay, California: California Div. Mines Bull. 149, 135 pp., 1949.

[6] Taff, J. A., Geology of Mount Diablo and vicinity: Geol. Soc. America Bull. 46, pp. 1079-1100, 1935.

[7] Jenkins, O. P., Geologic map of California, scale 1:500,000: California Div. Mines, 1938.

Industries. Contra Costa County is primarily an industrial county, ranking second among all counties in the 11 western states in value of manufactured products. During 1947 the value added by manufacturers to the total value of manufactured products in Contra Costa County was $155,150,000. Refining of petroleum is the leading industry. Four major oil companies, Shell Oil Company, Standard Oil Company of California, Tide Water Associated Oil Company, and Union Oil Company of California operate refineries in the county. Other important industries are sugar refining, steel-making, fruit and vegetable processing and canning, chemical manufacturing, and automobile assemblying. Other industrial products include metal, refractory, glass, paper, rubber, and clay products.[8] During World War II ships valued at more than $1,000,000,000 were constructed at Richmond. Agricultural products in 1946 were valued at slightly less than $22,000,000; the principal commodities being dairy products, livestock, nuts, fruits, and vegetables. Mineral production in Contra Costa County is substantial, aggregating $1,249,973 in 1949. Over two-thirds of the mineral output is consumed by the building industry of the county and the bay area. Clay for brick manufacture, crushed rock, and sand and gravel are the mineral commodities produced. Increasing diversification of industry in Contra Costa County will broaden the demand for mineral commodities available in the county.

The industrial areas of the county are mainly along tidewater from Richmond to Antioch. Two main line railroads, those of the Southern Pacific Company and the Santa Fe Railway Company traverse the industrial and eastern agricultural areas. A branch line of the Southern Pacific Company runs southward from Port Chicago through Concord, Walnut Creek, and Danville into Alameda County. A network of paved roads covers the county. Preliminary 1950 census figures present the following data: the population of Contra Costa County is 297,400, an increase of almost 200 percent since 1940; Richmond is the largest city with a population of 99,163; other cities with a population of more than 10,000 include Antioch, Concord, El Cerrito, Pittsburg, San Pablo, and Walnut Creek; Martinez, the county seat, has 8,215 inhabitants; the San Francisco Bay area has a population of about 2,500,000.

Industrial fuel, power, and water are abundant in Contra Costa County. Natural gas and petroleum products are the principal available fuels. Local oil refineries supply adequate amounts of liquid fuels. Natural gas is distributed to the county by the Pacific Gas and Electric Company. At present natural gas is obtained from the Rio Vista gas field, which extends into northeastern Contra Costa County from Solano and Sacramento Counties. To insure adequate supplies for the future, a 34-inch pipeline has been constructed linking the San Francisco Bay area with Texas and New Mexico natural gas sources. Natural gas rates effective during August 1950 in Contra Costa County are shown in table 1.

Table 1. Cost of industrial natural gas service.[9]

First 100 M cu. ft., per M cu. ft.*	35.3¢
Next 900 M cu. ft., per M cu. ft:	34.3¢
Next 2000 M cu. ft., per M cu. ft.	33.3¢
Over 3000 M cu. ft., per M cu. ft.	32.3¢

* 1000 cubic feet.

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[8] A complete list is published yearly by the Contra Costa County Development Association, 838 Escobar Street, Martinez.

[9] Revised California Public Utilities Commission Sheet 2803-G, effective July 15, 1950.

The above rates are applicable along existing mains having sufficient excess capacity. The natural gas delivered contains 1050 British thermal units per cubic foot.

Low cost electrical energy is supplied to the county through the power grid of the Pacific Gas and Electric Company from hydroelectric plants in the Sierra Nevada, supplemented by steam-powered generating plants in the San Francisco Bay area. A steam-powered generating plant of 402,000 horsepower is scheduled for completion during 1951 near Antioch on the San Joaquin River. Power rates effective April 15, 1950, are shown in table 2.

Table 2. General power: connected load basis: alternating current.[10]
(Subject to minimum charges and special conditions)

Horsepower of connected load	*First 50 kwh. per hp.*	*Next 50 kwh. per hp.*	*Next 150 kwh. per hp.*	*All over 250 kwh. per hp.*
2-9.9 hp.	4.13¢	2.23¢	1.27¢	.95¢
10-24.9 hp.	3.60	2.12	1.17	.95
25 hp. and over	3.07	2.01	1.06	.85

The most important sources of water for the county are the East Bay Municipal Utilities District serving the western part of the county; the Contra Costa Canal, part of the Central Valley Project, serving the northern part of the county; and the California Water Service Corporation, serving interior communities. Some water is pumped from wells and from the bay.

MINES AND MINERAL RESOURCES

Contra Costa County's total recorded mineral production, 1894-1949, is valued at $81,612,511. In addition, coal valued at $14,300,000 was mined from the Mount Diablo field between 1867 and 1882. An undetermined amount of mercury was produced prior to 1894.

Contra Costa County ranked thirtieth among California's 58 counties in value of mineral production during 1949. Mineral commodities produced that year were valued at $1,249,973. Peak production was reached during 1943 when the value was given as $4,284,821, ranking the county fifteenth in the state that year. Details of production data for 1948 and 1949 are shown in table 3.

*Table 3. Contra Costa County mineral production 1948 and 1949.**

	1948		*1949*	
	Quantity	*Value*	*Quantity*	*Value*
Sand and gravel, short tons	372,013	$252,229	361,245	$158,889
Stone, short tons	499,110	586,904	547,680	603,310
Unapportioned: clays, natural gas, peat (1948-49), and pumice (1948)	------	416,443	------	487,774
Total value		$1,255,576		$1,249,973

* These figures are furnished by the U. S. Bureau of Mines in cooperation with the California Division of Mines.

In addition to the mineral commodities mentioned in table 3, the following substances have been produced commercially in the county: cement, coal, copper, limestone, mercury, and mineral water. A small production of asbestos, diatomite, and lead has been recorded. The following are mentioned in a recent Division of Mines bulletin as minerals occurring in Contra Costa County:[11]

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[10] Revised California Public Utilities Commission Sheet 1837-E, 1950.

Actinolite
Albite
Anauxite
Anthophyllite
Apatite
Barite
Bornite
Chalcopyrite
Chalcocite
Chromite
Cinnabar
Coal
Copiapite
Crossite
Diallage
Diopside
Enstatite
Epsomite
Fluorite
Halotrichite
Lawsonite
Marcasite
Melanterite
Metacinnabar
Potash alum
Pyrochlorite
Psilomelane
Pyrolusite
Romerite
Rutile
Siderotil
Sphene
Stibnite
Tremolite
Zaratite

Metallic and Nonmetallic Mineral Commodities

Asbestos

Small occurrences of asbestos have been noted in the serpentine of the Mount Diablo area, mainly in T. 1 N., R. 1 E.[12]

Cement

Portland cement was produced continuously in Contra Costa County from 1909 to 1946 by the Henry Cowell Lime and Cement Company. Although this operation has been discontinued, the value of the cement produced at this plant exceeds that of any other mineral commodity produced in the county. The plant is to be sold and removed from the property. Depletion of the limestone deposits is given as the reason for closing the plant.

Henry Cowell Lime and Cement Company. Location: secs. 8, 9, 16, 17, T. 1 N., R. 1 W. (projected), on Rancho del Diablo, 3 miles southeast of Concord. Ownership: Henry Cowell Lime and Cement Company, 2 Market Street, San Francisco.

The predecessor, Henry Cowell Lime Company, began operations in this area in 1904, producing lime from the limestone of Lime Ridge. Kilns were originally in Concord, but were later shifted to Cowell. Construction of the cement plant began in 1907, cement production beginning in 1909. In 1916 the Cowell organization bought the holdings of the Spreckels Sugar Company, operators of a lime plant on contiguous land on Lime Ridge.

A detailed description of the cement plant and mining operations was made in 1927 by Laizure.[13] No major changes were made in the plant from 1927 until it was closed in 1946. The plant had a rated capacity of 4800 barrels of cement per day. When operation ceased, 3500 barrels per day were being produced. The cement made here was sold under the trade name "Mt. Diablo."

Limestone and clay for the cement operation were obtained from Lime Ridge, a northwesterly spur of Mount Diablo. The limestone deposits on Lime Ridge, mainly in secs. 8, 9, 16, 17, T. 1 N., R. 1 W., are irregular masses of travertine, calcareous spring deposits, overlying calcareous sandstone of the Tejon formation (Eocene). These superficial

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[11] Murdoch, Joseph, and Webb, R. W., Minerals of California: California Div. Mines Bull. 136, 402 pp., 1948.

[12] Laizure, C. McK, op. cit., pp. 6-7, 1927.

[13] Laizure, C. McK, op. cit., pp. 9-12, 1927.

Table 4. Mineral production o

Year	Brick		Coal*		Lime		Limestone	
	M	Value	Tons	Value	Barrels	Value	Tons	Value
1894	----------	----------	35,000	$94,000	----------	----------	----------	----------
1895	----------	----------	48,635	139,655	----------	----------	----------	----------
1896	150	$4,500	44,892	118,709	----------	----------	----------	----------
1897	----------	----------	39,267	105,180	----------	----------	----------	----------
1898	5,000	25,000	47,000	113,340	----------	----------	----------	----------
1899	----------	----------	53,013	131,613	----------	----------	----------	----------
1900	----------	----------	51,248	145,000	----------	----------	----------	----------
1901	----------	----------	35,000	100,000	----------	----------	----------	----------
1902	800	11,600	13,960	31,160	----------	----------	----------	----------
1903	2,600	16,000	----------	----------	5,300	$4,500	18,000	$22,500
1904	9,385	67,495	----------	----------	12,187	10,359	----------	----------
1905	10,979	73,948	----------	----------	20,244	13,925	34,800	43,500
1906	23,267	169,022	----------	----------	----------	----------	----------	----------
1907	48,573	403,564	----------	----------	1,413	1,413	22,038	43,038
1908	55,844	335,737	----------	----------	----------	----------	9,140	18,282
1909	41,033	268,122	----------	----------	14,062	15,468	22,556	42,837
1910	30,284	199,079	----------	----------	17,338	14,750	22,912	37,064
1911	36,463	271,575	----------	----------	11,872	8,645	68,708	46,208
1912	32,621	283,718	----------	----------	14,870	12,640	25,879	45,291
1913	30,411	212,953	----------	----------	150,551	127,968	26,259	34,976
1914	16,064	129,543	67	268	5,666	4,724	32,657	43,661
1915	14,915	139,862	[2]	----------	----------	----------	11,989	14,565
1916	16,672	148,730	[2]	----------	----------	----------	[2]	----------
1917	and tile	172,653	[2]	----------	----------	----------	----------	----------
1918	and tile	148,831	----------	----------	----------	----------	----------	----------
1919	----------	[2]	----------	----------	----------	----------	----------	----------
1920	13,608	312,398	----------	----------	----------	----------	----------	----------
1921	----------	[2]	----------	----------	----------	----------	----------	----------
1922	and tile	307,749	----------	----------	----------	----------	----------	----------
1923	----------	[2]	----------	----------	----------	----------	----------	----------
1924	and tile	327,225	----------	----------	----------	----------	----------	----------
1925	----------	[2]	----------	----------	----------	----------	----------	----------
1926	----------	[2]	----------	----------	----------	----------	[2]	----------
1927	----------	303,302	----------	----------	----------	----------	[2]	----------
1928	[2]	----------	----------	----------	----------	----------	----------	----------
1929	[2]	----------	----------	----------	----------	----------	----------	----------
1930	----------	----------	----------	----------	----------	----------	----------	----------
1931	[2]	----------	----------	----------	----------	----------	----------	----------
1932	[2]	----------	----------	----------	----------	----------	----------	----------
1933	and tile	268,235	----------	----------	----------	----------	----------	----------

ontra Costa County, 1894-1949.

Mineral water		Miscellaneous stone,[1] value	Miscellaneous and unapportioned		
Gallons	Value		Amount	Value	Substance
--------	--------	--------	--------	--------	Quicksilver, 1875-1877 (inc.).[4]
--------	--------	--------	--------	--------	
7,600	$3,700	$9,000	1,400 tons	$2,200	Pottery clay.
5,000	1,200	--------	--------	--------	
9,300	3,100	--------	--------	--------	
10,000	3,500	--------	--------	--------	
12,000	1,900	--------	--------	--------	
12,000	1,900	--------	--------	--------	
31,200	8,736	--------	31,700 lbs.	3,645	Copper.
78,000	19,500	--------	--------	--------	
78,000	19,000	23,000	--------	--------	
[2]	--------	76,120	--------	--------	
--------	--------	75,025	--------	--------	
--------	--------	210,250	2,057 tons	21,870	Asphalt.[6]
109,400	5,470	236,047	9,500 tons	123,500	Asphalt.[6]
			6,000 tons	7,500	Pottery clay.
199,800	10,590	233,782	17,085 tons	222,105	Asphalt.
			--------	683,392	Unapportioned, 1900-1909.
2,500	375	235,655	--------	--------	
206,500	10,325	257,503	--------	--------	
200,000	10,000	478,162	--------	--------	
192,292	4,989	660,405	--------	921,349	Other minerals.
364,288	3,643	308,727	--------	658,755	Other minerals.
[3]350,000	4,000	397,330	--------	757,748	Asbestos, cement, coal.
351,724	6,154	363,753	--------	760,423	Cement. clay, coal, limestone.
436,265	8,563	322,507	--------	772,934	Cement and coal.
30,376	3,038	324,884	100 tons	300	Pottery clay.
			--------	847,198	Cement and copper.
[2]	--------	275,309	--------	193,340	Clay and clay products.
			--------	926,909	Cement and mineral water.
--------	--------	432,654	1,743 tons	3,319	Pottery clay.
			--------	1,333,682	Cement and mineral water.
600,300	6,099	415,127	--------	198,248	Clay and clay products.
			--------	1,003,258	Other minerals.
--------	--------	559,915	7,086 tons	12,910	Pottery clay.
			--------	1,516,738	Cement, limestone, mineral water.
--------	--------	629,216	--------	281,743	Clay and clay products.
			--------	1,761,985	Cement, limestone, mineral water.
--------	--------	646,369	--------	1,374,496	Clay (pottery), cement, limestone, mineral water.
--------	--------	708,159	--------	1,836,020	Clay (pottery), and clay products, cement, limestone, mineral water.
[2]	--------	766,921	--------	448,584	Clay and clay products.
			--------	1,395,048	Cement, limestone, and mineral water.
[2]	--------	816,140	--------	1,053,314	Cement, clay (pottery), limestone, and mineral water.
[2]	--------	590,792	--------	1,609,690	Brick and hollow tile, cement, clay, coal, mineral water.
[2]	--------	413,837	7,003 tons	6,327	Pottery clay.
			--------	1,407,792	Brick and hollow tile, cement, mineral water, glass sand.
[2]	--------	398,613	--------	102,036	Gold.
			199,186 fine ozs.	76,687	Silver.
			--------	1,065,950	Brick and hollow tile, cement, clay, mineral water, quicksilver, glass sand.
[2]	--------	315,825	5,368 tons	3,813	Pottery clay.
			--------	973,204	Brick and hollow tile, cement, mineral water, glass sand.
[2]	--------	231,590	--------	782,403	Brick and hollow tile, cement, clay, mineral water, quicksilver, glass sand.
[2]	--------	322,483	--------	641,253	Cement, clay, mineral water, glass sand.

Table 4. Mineral production of Cont

Year	Brick		Coal*		Lime		Limestone	
	M	Value	Tons	Value	Barrels	Value	Tons	Value
1934	[2]	----------	----------	----------	----------	----------	----------	----------
1935	----------	$368,028	----------	----------	----------	----------	----------	----------
1936	----------	423,887	----------	----------	----------	----------	----------	----------
1937	----------	497,543	----------	----------	----------	----------	----------	----------
1938	----------	483,961	----------	----------	----------	----------	----------	----------
1939	----------	695,508	[2]	----------	----------	----------	----------	----------
1940	----------	[2]	[2]	----------	----------	----------	----------	----------
1941	----------	[2]	[2]	----------	----------	----------	----------	----------
1942	----------	[2]	----------	----------	----------	----------	----------	----------
1943	----------	[2]	----------	----------	----------	----------	----------	----------
1944	----------	[2]	----------	----------	----------	----------	----------	----------
1945	----------	[2]	----------	----------	----------	----------	----------	----------
1946	----------	[2]	----------	----------	----------	----------	----------	----------
1947	----------	[5]	----------	----------	----------	----------	----------	----------
1948	----------	[5]	----------	----------	----------	----------	----------	----------
1949	----------	[5]	----------	----------	----------	----------	----------	----------
Totals	388,669	$7,069,768	368,082	$978,925	253,503	$214,392	294,938	$391,92

Grand total value, $81,612,511

[1] Includes crushed rock, rubble, riprap, sand, gravel. After 1946 sand and gravel is separated.
[2] See under "Unapportioned."
[3] Estimated.
[4] The Ryne Mine on Mt. Diablo was active in 1875-1877 (inc.) and produced as high as 85 flasks per month at one stage; but total amount not available.

limestone deposits were 20 feet thick in places. During operation of the cement plant, Lime Ridge became pock-marked by limestone and clay quarries linked to the plant area by a network of roads.

The following is a brief description of the operations of the company. The exploitable parts of the limestone deposits were delineated by churn drilling. Holes for blasting were also drilled with a churn drill. An electric-powered shovel loaded to hopper bottom cars, which were pulled to the plant by a steam locomotive. Cement was made here by the dry process. Gyratory crushers were used for primary size reduction, followed by raw grinding in tube mills. After blending for composition control, the raw grind was passed to six rotary kilns 100 feet long by 7½ feet *osta County, 1894-1949—Continued.*

Mineral water		Miscellaneous stone,[1] value	Miscellaneous and unapportioned		
Gallons	Value		Amount	Value	Substance
[2]	----------	$408,412	----------	$1,326,587	Brick and hollow building tile, cement, pottery clay, mineral water, sandstone, silica (glass sand).
[2]	----------	274,237	----------	719,351	Cement, clay, copper, lead, mineral water, silica.
		427,731	14,245 tons	15,931	Pottery clay.
[2]	----------		----------	837,582	Cement, mineral water, quicksilver, glass sand.
[2]	----------	518,760	----------	851,006	Cement, clay, mineral water, quicksilver, silica.
[2]	----------	433,644	----------	1,198,680	Cement, clay, mineral water, quicksilver, silica.
[2]	----------	320,320	----------	1,190,303	Cement, clay, coal, gems, mineral water, quicksilver, silica.
[2]	----------	278,477	----------	1,960,631	Brick and tile, cement, clay, coal, diatomite, mineral water, quicksilver, glass sand.
[2]	----------	769,537	----------	2,493,554	Brick and tile, cement, mineral water, natural gas, quicksilver, glass sand.
[2]	----------	1,153,454	----------	2,913,022	Brick and tile, cement, mineral water, quicksilver, silica (glass sand).
[2]	----------	1,171,432	----------	3,113,389	Brick and hollow tile, cement, clay (pottery), mineral water, natural gas, quicksilver, silica (glass sand).
[2]	----------	942,406	----------	2,301,773	Brick and hollow tile, cement, mineral water, natural gas, quicksilver, silica (glass sand).
[2]	----------	687,560	----------	1,808,972	Brick and hollow tile, cement, mineral water, natural gas, pumice, quicksilver, silica (glass sand).
[2]	----------	669,497	----------	2,597,475	Brick, hollow tile, cement, mineral water, natural gas, pumice, quicksilver, silica (glass sand).
		509,546	378,734 tons	248,403	Sand and gravel.
--------	----------		----------	647,733	Raw clay, natural gas, pumice.
		586,904	372,013 tons	252,229	Sand and gravel.
--------	----------		----------	416,443	Raw clay, natural gas, peat, pumice.
		603,310	361,245 tons	158,889	Sand and gravel.
--------	----------		----------	487,774	Clays, natural gas, peat.
,286,545	$135,782	$21,490,327	----------	$51,331,395	

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[5] Included with heavy clay products. Value not added to county total.
[6] Asphalt recovered at oil refineries from oil produced outside the county.

* Coal mining began in the Mount Diablo section of Contra Costa County at least as early as 1861, but there re no segregated county figures available earlier than those here shown. For 1867-1882 (inc.) there are records hat indicate for the Mount Diablo field a total of approximately 2,500,000 tons, valued at $14,300,000.

in diameter. The clinker from the kilns passed to four rotary coolers, and thence to storage bins having a combined capacity of 225,000 barrels. Finish grinding was done in two stages: ball mills, followed by tube mills. Gypsum was added prior to the first stage of finish grinding. Storage bins with an aggregate capacity of 120,000 barrels of finished cement received the output of the finish grinding department. Cement was shipped from the plant in sacks and bulk, in trucks and railroad cars.

Chromite

Land purported to contain chromite has been prospected but no commercial production has resulted. One such property is in T. 1 N.,

R. 1 W., called the Mt. Zion chrome mine.[14] As elsewhere in the Coast Ranges the chromite occurrences have been noted in serpentine areas.

Clay

Clay production was one of the earliest industries of the county, beginning prior to 1868. At that time clay for fire-brick, crucibles, and stoneware was obtained from the Black Diamond coal mine at Nortonville and Marsh's Ranch. In the period 1868-86 the Albion Pottery Company was making pottery at Antioch from clay mined at the Brentwood coal mine. To date at least a dozen organizations have mined clay in the county.

Several plants utilizing clay mined in other counties are in Contra Costa County. Gladding, McBean and Company produces refractories from Ione fire clay at their Pittsburg plant, one of the largest of its kind in the state. The California Art Tile Corporation, the Technical Porcelain and Chinaware Company, and the American Radiator and Standard Sanitary Manufacturing Company all manufacture ceramic products from materials obtained outside the county. Although high grade clay is not abundant, a substantial brick industry derives its raw materials from the clay shales of the county. At present, two brick plants are operating: one at Port Costa and one at Point Richmond.

Port Costa Brick Works. Location: sec. 10, T. 2 N., R. 3 W. (projected), on Carquinez Strait, three-quarters of a mile east of Port Costa. Ownership: Port Costa Brick Works, 401 Berry Street, San Francisco; plant superintendent is Lawrence Mossina.

Common brick is the only product of this plant. Daily plant capacity is 50,000 bricks. The plant was established in 1905 and has operated almost continuously to the present. The holdings of this company embrace 140 acres, which include the plant and quarry areas. Most of the required clay is mined from pits on the property; some clay is obtained from Lincoln, Placer County. About 150 tons of brown and blue clay shale is mined per day near the plant. The clay shales are interbedded with a series of steeply dipping sandstones of the Chico formation (Upper Cretaceous). The clay shale is usually mineable without blasting. Power shovels dig and load the clay shale to trucks which haul to the plant, a distance of about 1000 feet. At the plant two stages of grinding prepare the material for blending with Lincoln clays, after which the clay is extruded through a die and cut into bricks using standard equipment. The bricks are dried either in open air sheds or artificially, depending upon weather conditions.

One Hoffman continuously fired coal burning kiln is used for burning the brick during winter months. During the summer months, the time of high demand, several gas-fired field kilns supplement the production from the Hoffman kiln. One section of the Hoffman kiln is fired while the burned bricks are removed and replaced by unfired bricks in another section. Bricks remain in the kiln for about 2 weeks. About 5 tons of Utah bituminous coal, supplemented with 25,000 cubic feet of natural gas, is used per day to fire the Hoffman kiln. During the operation of the field kilns about 45,000 cubic feet of natural gas is consumed hourly.

A recent improvement in the operation of this plant is the adoption of power lifts for removing brick from the kiln, which decreases brick breakage during unloading. At present all brick is shipped from the plant by truck. Before World War II some brick was moved by barge.

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[14] Laizure, C. McK, op. cit., p. 12, 1927.

United Materials and Richmond Pressed Brick Company. Location: sec. 23, T. 1 N., R. 5 W., at Point Richmond on San Francisco Bay, immediately north of the new natural gas storage tank of the Pacific Gas and Electric Company. Ownership: United Materials and Richmond Pressed Brick Company, Ltd., Box 7, Point Richmond.

This plant was established in 1907 by the Los Angeles Pressed Brick Company. It became an independent operation in 1921 under the name Richmond Pressed Brick Company; in 1930 the present name was adopted. The company controls about 40 acres of land at Point Richmond. At present 35 men are employed at the plant, producing 25,000 bricks per day. The principal raw material used for brick making is blue clay shale quarried from the Franciscan formation (Upper Jurassic) near the plant. Large reserves of this material are available on the property. High-grade clay from Lincoln, Placer County, and Ione, Amador County, constitutes about 30 percent of the material used in the bricks. A caterpillar with bulldozer digs the shale and pushes it within reach of an overhead clamshell crane, which feeds it to the crushing and grinding machinery; the same crane also unloads clay from railroad gondola cars. The raw materials are ground until they pass a 10- to 12-mesh screen and are then conveyed to storage bins of 2000-ton capacity, from which they are drawn for mixing, pressing, and cutting. The stiff-mud process is used for making most of the bricks. The bricks are dried in waste-heat tunnel driers before being sent to the kilns. Six kilns, each 36 feet in diameter having a capacity of 100,000 bricks, are used for firing. At present the kilns are oil-fired, but it is anticipated that natural gas will replace the oil in the near future. Bricks are fired for 1 week, being stacked in and removed from the kilns by hand. Special type bricks, which are easily damaged, are individually wrapped in paper when removed from the kiln. Almost all brick produced here is shipped by truck.

Only face brick is made at this plant. Conventional face brick made here includes: Richmond red wire-cut, red ruffle, rug face, standard, repressed paving brick, buff, and buff rug. Six types of Roman-size face brick, and three types of Norman-size face brick are also made. Miscellaneous face bricks made are: split repressed paver brick and brails brick. Since the last report a new office and kiln have been built at the plant.

Copper

Copper was produced in Contra Costa County during 2 years, 1902 and 1918, and amounted to less than 40,000 pounds. All of this output is attributed to the Mount Zion mine in sec. 27, T. 1 N., R. 1 W., about half a mile south of Mount Zion, a subordinate peak on the northwest flank of Mount Diablo. One other prospect, the Eagle Peak, in sec. 26, T. 1 N., R. 1 W., is in rocks of the Franciscan formation.

Diatomite

Substantial quantities of diatomite are present in the Tertiary sedimentary rocks of the county, particularly in the Monterey group. Some exploratory work has been done along the south shore of San Pablo Bay, west of Pinole, where diatomite crops out over a large area. Weaver[15] has mapped the area as Tice shale and Pinole tuff.

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[15] Weaver, C. E., op. cit., 1949.

The diatomite is white to buff, containing numerous calcareous fossil remains. Microscopic examination reveals a high diatom content and the presence of considerable tuffaceous material.

No commercial production of diatomite has been reported.

Gold

No gold or silver has been recovered from ore mined in Contra Costa County. Production recorded in 1930 was from ''left-over residues and smelter materials of abandoned reduction plants'' in the county.[16] Primary ore processed in these plants originated elsewhere.

Limestone

A recent publication of the Division of Mines describes the limestone deposits of the county.[17]

Limestone mined in connection with cement manufacture constituted one of the most valuable mineral materials produced in the county. Mining limestone for cement-making ceased in 1946, when the cement plant of the Cowell Lime and Cement Company was shut down. Several operators have produced limestone in a small way from time to time.

Limestone is not abundant in Contra Costa County, but it is widely distributed. The largest deposits of high-grade limestone were on Lime Ridge, a northwesterly spur of Mount Diablo. The best material has been removed from these deposits for the manufacture of cement. These deposits are travertine of Quaternary age (see *Cement*). Lenses of limestone are common in the Cretaceous and Tertiary sediments of the county. The following quotation describes the nature and distribution of limestone in the Concord quadrangle west of Mount Diablo: [18]

> "A few thin lentils of limestone occur in the Cretaceous rocks, but they have no commercial value. There are also many lentils of impure ferruginous and phosphatic limestone in the bituminous shales and cherts of the Monterey group.
>
> "In the Orinda and Siesta formations limestone lenses occur more or less persistently at several horizons, and similar beds of limestone are interstratified with the lavas of the Moraga formation. All these lenses are of lacustral formation and most of them are siliceous. The best that can be said of them as to their economic value is that some of them may prove to be of service for local use."

The Orinda, Siesta, and Moraga are Pliocene formations which crop out in the hilly area between Mount Diablo and San Francisco Bay.

Limestone was first produced in Contra Costa County in 1851 and has been produced almost continuously since then. Between 1875 and 1900, Contra Costa County limestone was shipped to Benicia for use in portland cement manufacture.[19] Records of limestone production were first compiled in 1903; at that time Spreckels Sugar Company was making lime at a plant 5 miles southeast of Concord from limestone mined at Lime Ridge. Output from this plant was used at the Spreckels refinery and at the Selby smelter. This lime operation was discontinued in 1916 when it was purchased by the Henry Cowell Lime and Cement Company.

Mount Diablo Lime Marl Company produced limestone from 1924 to 1927 from a deposit on Lime Ridge. Most of the limestone produced in this operation was ground and screened for agricultural uses. No production has been made by this company since 1927.

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[16] Heikes, V. C., Gold, silver, copper, lead, and zinc in California: Mineral Resources of the United States 1930, Part 1, Metals, U. S. Bur. Mines, p. 989, 1933.

[17] Logan, C. A., Limestone in California: California Jour. Mines and Geology, vol. 43, pp. 220-222, 1947.

[18] Lawson, A. C., op. cit., p. 22, 1914.

[19] Grimsley, G. P., The portland cement industry of California: Eng. and Min. Jour., vol. 72, no. 3, pp. 71-72, 1901.

Manganese

Only one potentially commercial deposit of manganese is known in Contra Costa County. This deposit lies on the southwest side of Red Rock Island, an island in San Francisco Bay, 1 mile southwest of Point Castro, in sec. 17, T. 1 N., R. 5 W. (projected). The deposit was described by Lawson.[20] Essentially the same description has been included in previous Contra Costa County reports and in a recent Division of Mines Bulletin.[21] Briefly the manganese mineral psilomelane is rhythmically interbedded with red radiolarian chert of the Franciscan formation (Upper Jurassic). The beds have a near-vertical dip and strike west-northwest. Most of the psilomelane layers are 0.2 to 0.5 inch thick. The width of the manganese-rich zone in the chert has not been determined. Production in 1867 of possibly 200 tons of ore from this deposit has been reported.[22] In previous reports small deposits of manganese have been mentioned as occurring east of Mount Diablo.[23]

Mercury (Quicksilver)

Several occurrences of mercury minerals have been noted in the Franciscan rocks of the Mount Diablo area. The only known commercial deposits have been exploited at the Mount Diablo mine.

Mount Diablo mine (Ryne). Location: SE$\frac{1}{4}$ sec. 29, T. 1 N., R. 1 E., on the northeast slope of the North Peak of Mount Diablo about 4 miles southeast of Clayton. Ownership: Mount Diablo Quicksilver Co., Ltd., c/o Bradley Mining Company, Crocker Building, San Francisco.

The mine is currently inactive, mercury being last produced in 1946. Total recorded production is 10,749 flasks, an unknown quantity being produced during the period 1875 to 1877, perhaps as much as 85 flasks per month.[24] Following the 1875-1877 productive period, the deposit lay idle until 1930 when production was resumed. Most of the mercury production from the mine was made in the period 1939 to 1946.

An extensive account of the geology and history of this mine has been published.[25] The following is quoted from the abstract of that report:

> ". . . The lodes are in fracture zones near the footwalls of inclined, more or less tabular serpentine masses in Franciscan rocks. They are thought to have been formed by hot-spring action so recent that it is still giving rise to sulphurous gases and methane. The lodes are unique in that metacinnabar is an abundant primary ore mineral. The ore shoots are in zones of intense brecciation and are controlled in part by cross fractures."

Development of the deposits is localized in two areas: the Mill workings, and the Rhyne and Jones tunnels. Most of the mercury has been obtained from the Mill workings where underground and surface mining methods have been used. The underground workings are entered through an adit whose portal is near the mill. Three levels lie below the adit and are connected by winzes. These workings aggregate at least 3000 linear feet, not including sizeable stoped areas. Mining with power shovels on the surface has proceeded on several benches and a glory hole has been developed directly above the underground workings. In places, the surface workings have penetrated to the underground openings. The deposits have been exposed through a vertical range of 400 feet.

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[20] Lawson, A. C., op. cit., p. 23, 1914.

[21] Trask, P. D., and others, Manganese deposits of California: California Div. Mines Bull. 152, p. 50, 1950.

[22] Jenkins, O. P., and others, Manganese in California: California Div. Mines Bull. 125, p. 76, 1943.

[23] Laizure, C. McK, op. cit., p. 16, 1927.

[24] Irelan, William, Jr., Contra Costa County: California Min. Bur. Rept. 8, p. 162, 1888.

[25] Ross, C. P., Quicksilver deposits of the Mount Diablo district, Contra Costa County, California: U. S. Geol. Survey Bull. 922-B, p. 31, 1940.

The Rhyne and Jones tunnels, 1500 feet west of the Mill workings, consist of about 1200 feet of adits and drifts which explore a northwestward trending breccia zone. These were the earliest underground workings.

Ore produced from the underground Mill workings contained an average of about 0.50 percent mercury (10 pounds of mercury per ton). Ore remaining in the pit averages 3 pounds of mercury per ton.

Shortly after the mining of mercury ore ended in 1946, crushers were installed to make aggregate from silicified Franciscan sandstone. The plant was in continuous operation for about 8 months but competition from more favorably located plants forced cessation of this operation. Production of aggregate is now on an intermittent basis (March 1951).

Mineral Water

Mineral water has been produced almost continuously in Contra Costa County since 1896. Statistics on the quantity and value of this water have not been compiled since 1946. Only data concerning water bottled for sale were included in the statistics.

Most of the springs of the county were described by Waring.[26] The 1927 Contra Costa County report contains a summary of Waring's descriptions[27] of Alhambra Springs, Byron Hot Springs, Ferndale Springs, Pine Canyon Spring, and Sulphur Spring near Walnut Creek. In recent years production has come from two springs, described as follows:

Alhambra Springs. Location: sec. 7, T. 1 N., R. 2 W. (projected), 5½ miles south of Martinez. Ownership: E. R. and L. W. Lasell, 700 Castro Street, Martinez. The above mentioned parties are the principals of the Alhambra Water Company, bottlers and distributors of the water.

This operation began in 1904 when the company laid a pipeline from the spring to Martinez. At first they made soft drinks from mineral water. In 1910 they began to sell the spring water in 5-gallon bottles and to make shipments in railroad tank cars to San Francisco and Oakland where it was bottled. By 1918 the company had ceased making soft drinks, but since that time they have continually produced bottled drinking water. During World War II, because of the irregularity of tank car service, the company discontinued tank shipments to San Francisco and Oakland.

Six springs are in the Alhambra group, flowing about 150,000 gallons per month. Table 5 gives analyses of the water as represented in advertising matter.

In the spring area an adit 75 feet long taps one of the springs. The water thus obtained is filtered through a gravel trough before entering a pipeline to Martinez. The pipeline, owned by the company, runs to the bottling plant at 316 Ferry Street, Martinez. Water is filtered again in the plant and then oxygenated with oxygen generated at the plant. The water is marketed in 5-gallon bottles. The present marketing areas include Concord, Crockett, Martinez, Pittsburg, and Walnut Creek. Production averages 10,000 gallons per month.

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[26] Waring, G. A., Springs of California: U. S. Geol. Survey, Water-Supply Paper 338, 410 pp., 1915.

[27] Laizure, C. McK, op. cit., pp. 16-19, 1927.

Table 5. Analyses of water from Alhambra Springs.
(Analyst, Thomas Price and Son)

	Grains per United States gallon	
	No. 1 spring	*No. 2 spring*
Calcium chloride	157.24	----
Magnesium chloride	24.25	----
Potassium chloride	7.58	1.395
Sodium chloride	492.65	2.028
Calcium bicarbonate	----	19.247
Magnesium bicarbonate	----	14.680
Sodium sulphate	2.48	15.548
Sodium sulphide	8.39	----
Ferrous carbonate	1.16	----
Aluminum oxide	----	0.238
Aluminum sulphate	2.13	----
Silicon dioxide	1.22	0.758
Total residue	697.10	53.894

Oak Springs. Location: S½ sec. 3, T. 1 S., R. 3 W., 1 mile south of the intersection of Tunnel Road and San Pablo Creek road, near Orinda. The springs are on the west side of San Pablo Creek. Ownership: Coy Filmer, 330 Jackson Street, San Francisco. Leased to Fox Water Company, R. E. Fox, owner and operator, 675-37th Street, Oakland.

These springs were originally used for domestic water supply. In 1934 the Fox Company leased the springs and produced water there continuously until mid-1949 when they ceased operations temporarily to clean out and improve the flow from the springs. In connection with this improvement program, a 25,000-gallon storage tank will be installed. As before, the water will be transported to the Oakland plant in tank trucks. At the plant the water is filtered and bottled. Daily production has averaged 300 to 1000 gallons. A large still is in operation at the Oakland plant and was operated at capacity during World War II to supply boiler water for navy ships. Eleven men are employed, most of them distilling and distributing water. The water is marketed in an area which includes the cities of Hollister, Los Gatos, Oakland, San Francisco, San Jose, and San Juan Bautista.

Pumice

Deposits of fragmentary pumice in Contra Costa County occur in the Pinole and Lawlor tuffs, Pliocene volcanic formations. These tuffs lie in the northern part of the county in the Los Medanos Hills, and near Pinole and Rodeo. The tuffs are in the Antioch, Carquinez, and Mare Island quadrangles as mapped and reported by Weaver.[28]

The Pinole tuff is described as follows:

> ". . . The basal part is a coarse, massive rock with very little evidence of bedding. The upper part is somewhat stratified and locally contains thin layers of tuffaceous clay shales. The tuff is generally light creamy white to brownish yellow and ranges from a very fine, compact, microcrystalline, glassy material to a coarse-grained pumice. Many angular fragments of vesicular lava ranging in size from five to six millimeters occur in the basal tuffs, and upon microscopic examination show labradorite feldspar and pseudomorphs of hornblende. . . ."

Near Rodeo, Pinole tuff is exposed in the trough of a northwest-trending syncline. From Wilson Point eastward to Pinole the tuff crops out along the south shore of San Pablo Bay, dipping 35° northward. According to Weaver, at Pinole and along Pinole Valley the tuff is down-dropped between two north-trending faults. The Pinole tuff consists of about 1000 feet of interbedded tuff, sand, and gravel resting on Neroly sandstone. The Pinole and Lawlor tuffs are similar lithologically and may be age equivalents.

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[28] Weaver, Charles, op. cit., pp. 60-61, 1949.

The Lawlor tuff crops out in a narrow west-northwestward trending belt along the north flank of the Los Medanos Hills, 2 to 3 miles from tidewater. It is interbedded with a series of shale, conglomerate, and sandstone beds, dipping 20° to 50° northward.

Two deposits southwest of Pittsburg has been mined for pumice intermittently since World War II. Most of the pumice has been used as aggregate in concrete building blocks.

Alvarnez. Location: sec. 15, T. 2 N., R. 1 W., 1½ miles northwest of the Bailey Ranch deposit. Ownership: M. Alvernez, Route 1, Box 589, Pittsburg. Leased to Pittsburg Pumice Industries, Route 1, Box 21, Pittsburg. The pumice is used as an aggregate in a small block plant 2 miles west of Pittsburg.

Bailey Ranch. Location: sec. 23, T. 2 N., R. 1 W., 3 miles southwest of Pittsburg. Ownership: A. S. Bailey, Bailey Road, Pittsburg. Leased to Diablo Pumibloc Company, Route 1, Box 163, Pittsburg. F. Gieg was leasing all facilities of the Diablo Pumibloc Company during the first part of 1950.

The pumice bed at the main pit is about 40 feet thick, and is interstratified with a series of tuff and sandstone beds that strike NW. 75°, and dip about 30° northward. The pumice bed lies on a dip slope, and is covered by about 3 feet of sandy overburden, which is removed by a bulldozer. Most of the pumice consists of pea-size fragments in a ground mass of clay. The bed is moderately well consolidated, breaking into large chunks and slabs when mined.

The pumice is loosened with a ''rooter'' drawn by a D-8 Caterpillar tractor. The larger pieces are crushed to 6 inches in size by running over them with the tractor. Then they are pushed down the hill to a drag-scraper which is used to feed pumice to the crushing plant. The crushing plant consists of grizzly, hammer mill, three 25-yard capacity bunkers, and an elevator for loading the bunkers. All the pumice is reduced to minus three-eighths inch diameter at this plant. Maximum capacity of the electrically operated crushing plant is 15 yards per hour.

Trucks haul the pumice to the block plant on Highway 4 at Bailey Road, and to independent block plants in the Sacramento Valley and the San Francisco Bay area. Some of the pumice is being used by gardeners and nurserymen as a soil conditioner. The conditioning effect is purely physical, and is most beneficial to heavy soils. It is possible that extensive agricultural applications of the pumice may be developed. This operation would be in a favorable position to participate in such a market.

At the block plant, operated by a 25 connected-horsepower load, the pumice is dumped into a ground level receiving bin from which it is elevated to storage bunkers of 35-cubic-yard capacity. A batch mix consists of 16 cubic feet of material, 14 cubic feet of which is aggregate composed of 80 percent pumice and 20 percent sand; the remaining 2 cubic feet is cement. The block pressing machine has a capacity of 1000 to 1200 units per day. Blocks are dried in an oven for 8 to 12 hours at

100° Fahrenheit, following which they are placed in a curing yard for about 28 days and are sprinkled occasionally with water. In the operating season, which includes about 8 months of spring, summer, and fall, three to four men are employed in the block plant and at the quarry. About 15 cubic yards of pumice (1600 pounds per yard) are used per day at the plant when operating at capacity. All the blocks are shipped by truck.

Sand—Aggregate

A narrow strip of Recent sand dunes extends along the southern shore of the San Joaquin River for a distance of about 2 miles eastward from the eastern limits of the City of Antioch. These dunes occupy parts of secs. 18, 17, 16, T. 2 N., R. 2 E., M. D., and attain an average width of about 800 feet. The original elevation of the dunes ranged from 65 to 115 feet but continued mining over a period of about 30 years has reduced their height in places from 25 to 100 feet. The sand is fine, yellow brown in color, unconsolidated, and consists chiefly of angular grains of silica tinted with iron oxide. Thin lenses of clay are distributed irregularly throughout the dune area.

C. W. Chesterman made a microscopic examination of one sample of dune sand and reported the following:

Table 6. Minerals present in Antioch dune sand.

Quartz	abundant	Biotite	rare
Feldspar		Hornblende	rare
Orthoclase	common	Zircon	rare
Plagioclase	common	Magnetite	rare

The ratio of quartz to feldspar was estimated at 2 to 1, and the magnetic fraction was estimated at 1½ percent. A screen analysis of the same sample is shown in table 7.

Table 7. Screen analysis of Antioch dune sand.

Screen size	Percent retained	Cumulative percent
On 30	4.8	4.8
40	4.6	9.4
50	6.5	15.9
60	7.9	23.8
80	16.6	40.4
100	12.2	52.6
120	8.5	61.1
140	8.3	69.4
200	13.6	83.0
Minus 200	17.0	100.0

It is interesting to note that a comparatively large fraction of the sand, 17 percent, passed the 200-mesh screen. Large quantities of sand are necessary for the ''mix'' used in various types of road construction, and sand from this area has proved particularly satisfactory in asphalt mixes. The usual specifications are that the sand be clean, hard-grained, moderately sharp, and with a 3 percent maximum of earthy impurities.

The operators in this dune area move the site of their operations from time to time as leases expire and other leases become available. Consequently, the locations given in this report (March 1951) are not the same as the locations described in earlier reports of the Division of Mines.

Antioch Sand Company. Location: SW¼ sec. 17, T. 2 N., R. 2 E., M. D., about 1.4 miles east of Antioch. Ownership: Antioch Sand Company, 1806-30th Avenue, San Francisco. Leased to Macal Construction Company. The plant is situated in the sand dunes. Railroad cars are outloaded from an overhead ramp at the rate of about six cars per day.

Basalt Rock Company. Location: SE¼ sec. 18, T. 2 N., R. 2 N., M. D., about a quarter of a mile northeast of the Morris pit. Lessee: Basalt Rock Company. The company has obtained sand from this dune area since 1936. A Caterpillar bulldozer moves the sand to a 50-foot conveyor belt leading to tidewater where facilities have been provided for barge-loading. Production at this pit is on a seasonal basis.

Henry J. Kaiser Company. Location: NE¼ sec. 28, T. 2 N., R. 2 E., M. D., about 3 miles southeast of Antioch at Newlove Siding. Ownership: Southern Pacific Company, 65 Market Street, San Francisco. Leased to Henry J. Kaiser Company, 1924 Broadway, Oakland. The mining of sand began in 1937 on a small mound of sand about 125 feet high trending northwestward. The surface of the pit area is now at an elevation of about 50 feet. The sand is unconsolidated, yellow brown in color, and consists predominantly of grains of quartz coated with films of iron oxide. Streaks of clay are encountered in places.

The sand is mined by a carryall pulled by a Caterpillar tractor equipped with a bulldozer. The carryall dumps to a pit grizzly above a 250-foot inclined conveyor belt. This belt dumps its load through another grizzly above a second 200-foot conveyor belt which delivers the sand to railroad cars through a debris screen. A half-inch screen is used in summer and a 1½-inch screen in winter. The larger screen is required in winter owing to the higher moisture content and caking tendency of the sand. This is an all-year operation employing five men on a 5-day week, and produces about five carloads per day. Most of the sand is sold to contractors.

Morris. Location: SE¼ sec. 18, T. 2 N., R. 2 E., M. D., 1 mile east of Antioch. Ownership: George Stamm, 5th and B Streets, Antioch. Leased to Ben Morris and W. G. McCullough, Route 1, Box 100, Antioch. Here an unconsolidated brown silica dune sand is used for asphalt mixes and concrete aggregate. Sand has been mined from this locality since 1921 and the dunes which formerly reached an elevation of about 115 feet are now reduced to an elevation of about 30 feet. A D-7 Caterpillar bulldozer moves the sand to a grizzly above a conveyor belt. The belt is about 125 feet long and delivers sand to either railroad cars or trucks. Two men were employed at this pit on a year round basis.

Wills, F. Location: SW¼ sec. 17, T. 2 N., R. 2 E. Ownership: J. Little, Route 1, Box 101, Antioch. Leased to F. Wills, Antioch, excavating and paving contractor. A Caterpillar bulldozer moves the sand from the dunes up a ramp to an overhead grizzly for truck loading.

Sand—Foundry and Glass

The sand deposits of California have supplied the foundry industry of this state for many years and this usage was summarized by Wright[29] who stated:

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[29] Wright, Lauren A., California foundry sands: California Jour. Mines and Geology, vol. 44, p. 38, 1948.

> "The state-wide foundry industry of California, with its substantial production of iron, steel, and non-ferrous metal castings, has, since its inception, drawn heavily on sands produced in the state. Consequently, the growth of a modest, but increasingly important foundry-sand industry has paralleled that of the foundries themselves. At present, the yearly production of California foundry sands is in the neighborhood of 90,000 tons. This tonnage is divided between clay-free sands and naturally bonded sands in the approximate ratio of three to two."

In Contra Costa County high silica sand for foundry use and for the glass industry has been produced for about 30 years. The production has been derived from deposits in a belt of middle Eocene sandstones and shales which crop out in the foothills on the northeast flank of Mount Diablo and extend from Concord to Byron, a distance of about 21 miles. The beds strike from west to N. 50° W. and dip from 25° N. to 40° NE. A total of 1,311,902 tons of sand valued at $5,093,889 has been produced from these deposits. These totals include 412,805 tons of molding sand valued at $1,534,308 and 899,097 tons of glass sand valued at $3,559,581. Within this belt the principal sand production has come from two localities; namely, the Brentwood area, and the Nortonville-Somersville area. The total sand production has been divided almost equally between the two areas.

Cowell. Location: sec. 8, T. 1 N., R. 1 W., M. D. (projected), half a mile south of Cowell. Ownership: Henry Cowell Lime & Cement Company, 2 Market Street, San Francisco.

Several hundred tons of sand per month are being removed from a pit in friable white to buff-colored sandstone formerly operated by the Henry Cowell Lime & Cement Company as a source of silica for use in cement manufacture. Most of the sand is now used as fill material under the concrete foundation slabs of houses. Some of the sand is used in the manufacture of asbestos shingles. A small tractor-type loader is used to dig and load the sand.

Marchio Sand Company (Antioch-Marchio). Property consists of two pits. Location: NW¼ sec. 11, T. 1 N., R. 1 E., M. D., and SW¼ sec. 12, T. 1 N., R. 1 E., M. D. Ownership: L. Ginochio, Route 1, Box 6, Antioch. Leased to Marchio Sand Company, Antioch.

A detailed description of this operation prepared by L. A. Wright[30] includes sieve and mineralogical analysis of the sand produced. Antioch-Marchio is the name applied by the foundry trade to the sands produced at this locality. Middle Eocene sandstone, similar to that mined in the Somersville-Nortonville area crops out through the center of sec. 11 and the SW¼ of sec. 12, and is the source of sand for this operation. The main pit of the Marchio Sand Company is at the old Star coal mine. The pit in sec. 11 was opened during the winter of 1950-51 when excessive rainfall made the other pit inaccessible.

In the main pit approximately 80 feet of sandstone is exposed. The excavation of several benches facilitates mining selectively the desired material which is of intermediate size, coarser sand being below and finer sand above. The sand is blasted down and then loaded by a power shovel to trucks for transfer to the processing plant on Oil Canyon road about half way between the pit and Antioch. Similar excavation methods are used at the second pit.

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[30] Wright, L. A., op. cit., pp. 40-41, 1948.

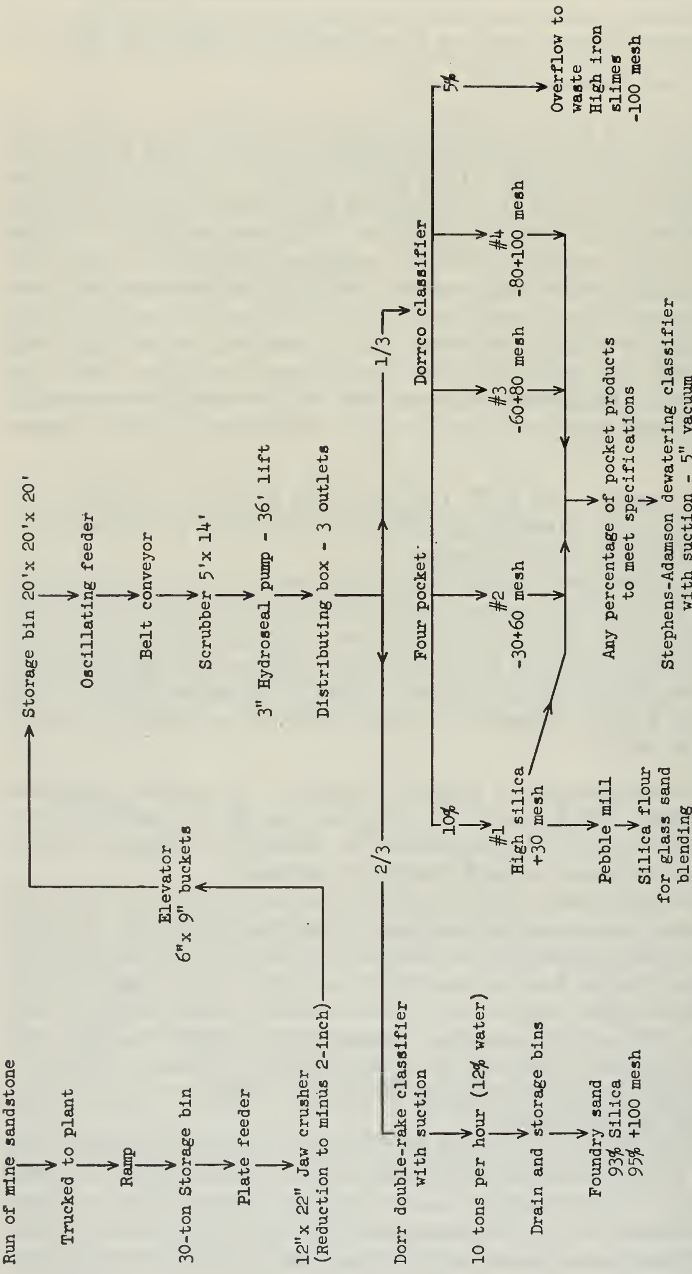
Run of mine sandstone
Trucked to plant
Ramp
30-ton Storage bin
Plate feeder
12"x 22" Jaw crusher
(Reduction to minus 2-inch)
Elevator
6"x 9" buckets
Storage bin 20'x 20'x 20'
Oscillating feeder
Belt conveyor
Scrubber 5'x 14'
3" Hydroseal pump - 36' lift
Distributing box - 3 outlets
2/3
1/3
Dorr double-rake classifier
with suction
10 tons per hour (12% water)
Drain and storage bins
Foundry sand
93% Silica
95% +100 mesh
Four pocket Dorrco classifier
10%
5%
#1
High silica
+30 mesh
#2
-30+60 mesh
#3
-60+80 mesh
#4
-80+100 mesh
Overflow to
waste
High iron
slimes
-100 mesh
Pebble mill
Silica flour
for glass sand
blending
Any percentage of pocket products
to meet specifications
Stephens-Adamson dewatering classifier
with suction - 5" vacuum
5 tons per hour (8% water)
Drain and storage bins
Specification sand

FIGURE 1. Flow sheet, Roberts Sand Company, Pittsburg plant.

At the plant the sandstone is disintegrated, scrubbed, and sized. According to the operator, the marketed material averages 95 percent silica. At present all output from this plant is being used by the Columbia Steel Company at Pittsburg.

Pittsburg Sand Company (Hazel-Atlas Glass Company of California, Ltd.). Location: SE¼ sec. 4, T. 1 N., R. 1 E., M. D., at Somersville. Ownership: Southern Pacific Company, 65 Market Street, San Francisco; and L. Ginochio, Rt. 1, Box 6, Antioch.

In September 1932 the Hazel-Atlas Glass Company purchased the lease on the Pittsburg mine at Somersville from the Industrial Mineral Sales Company. The new operator employed 20 men in mining and processing the sand which was crushed, washed, dried, screened, and used for the manufacture of container glass at their Oakland plant. In 1937 a subsidiary, the Pittsburg Sand Company, was formed to handle the mining and processing operations. The production of sand continued until the end of 1945 when the company was liquidated.

Roberts Sand Company[31] *(Roberts Bros. Silica Sand Company—The Roberts Bros.—T. G. Roberts—Columbia Steel Company).* Location: SE¼ sec. 5, T. 1 N., R. 1 E., M. D., at Nortonville. Ownership: Southport Land and Commercial Company, 220 Montgomery Street, San Francisco. Leased to Roberts Sand Company, Box 323, Pittsburg, California.

This group of successor companies mined and processed sand for use in the foundry of the Columbia Steel Company at Pittsburg over a period of nearly 25 years. During this time total production amounted to 367,543 tons of sand valued at $1,347,630. Before 1925 the Columbia Steel Company had obtained molding sand from a surface deposit near Brentwood for several years. The Brentwood deposit was abandoned in 1925 and the steel company began to obtain foundry sand from the Black Diamond coal mine at Nortonville. A lease to mine the sandstone beds overlying the Clark coal bed was negotiated with Southport Land and Commercial Company, owner of the property.

The deposit was mined by the room and pillar method utilizing hand auger drills. The sandstone was hand-loaded into cars which were drawn by mules through the 2000-foot tunnel and dumped into bunkers outside the portal. The material, trucked 6 miles to Pittsburg, was valued at $2.50 per ton f.o.b. plant. The steel company mined here through 1930, and was succeeded by T. G. Roberts who contracted to mine and supply sand to the foundry during 1931 and 1932. No production was reported in 1933 or 1934. Ed Roberts worked the deposit from 1935 to 1938. No production was reported in 1939, but in 1940 mining was reported by The Roberts Brothers. The washing plant, half a mile from the steel plant, was built in October 1938. About 20 men were employed from 1941 to 1945 in the mining and washing operation by the company, then known as Roberts Sand Company headed by T. H. Word and Peter Bugni. This group employed the sub-level method of mining. Drilling was done with drifter drills and cars were loaded with tugger or slusher hoists. Cars were drawn by a Baldwin western battery locomotive, and dumped into bunkers outside the mine portal. The sand was trucked to the processing plant near Pittsburg. Operations at this property were suspended in November 1949, owing to the closing of the foundry at the Columbia Steel Company plant.

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[31] Wright, L. A., op. cit., p. 42, 1948.

Silica Company of California. Location: sec. 6, T. 1 S., R. 3 E., M. D., 3½ miles south of Brentwood. Ownership: S. L. Longwell, Box 292, Brentwood. Leased to Owens-Illinois Glass Company, 601-36th Avenue, Oakland.

This company first reported sand production in 1929 from the Eocene sandstone deposits on Stone House Ranch, 3½ miles southwest of Brentwood, in sec. 36, T. 1 N., R. 2 E., M. D., projected. Sampson and Tucker described the operation in 1931.[32] At this locality the sandstone bed crops out in low rolling foothills along the west edge of the San Joaquin River delta area. The sand was removed through underground workings. Adits were driven southeastward along the strike of the beds and a system of room and pillar stopes was carried upward almost to the surface. These workings are now caved to the surface.

In 1934 the operations of this company were shifted about 1 mile southeastward to the North pit of the Longwell Ranch, where a similar system of mining was employed. These workings, which are now caved, extended southeastward along the strike for about half a mile to the property line of the ranch. In 1938 operations were transferred to the South pit of the Longwell Ranch. The South pit was an open cut operation. Mining began at the north end and was extended southeastward along the strike.

An extensive plant was built in 1931 near the Southern Pacific Railroad, 2½ miles southeast of Brentwood. Here the crude sand was processed and a low-iron (0.045 percent) glass sand was prepared. After screening out the oversized material, the sand was washed and classified to remove the fines. Chemical leaching was employed to reduce the iron content. The finished product was suitable for use in glassmaking, and in the manufacture of silicate of soda. Three grades of foundry sand were also prepared from the washed and screened sand, as follows: #1 Foundry, fine grain for gray iron work; #2 Foundry, minus 20-mesh plus 80-mesh, for standard steel moldings; #3 Foundry, minus 10-mesh plus 40-mesh (coarse), for steel breather sand. About 40 men were employed in 1931. The number of employees increased to 57 in 1936 and declined from that figure to 32 in 1940. Operations ceased in August 1942. The plant was removed and the company was liquidated.

A small pit on a knoll midway between the North and South pits on the Longwell Ranch is designated as the Central pit. Here, sand for foundry use was mined by the Columbia Steel Company during the 1920's.

Stone

Large quantities of crushed rock and riprap have been produced for many years in Contra Costa County. Since the closing of the cement plant at Cowell in 1946, the annual value of the stone output has exceeded that of every other mineral commodity produced in the county. In recent years, four quarries and rock plants have been operating. Intense building activity in the east bay area during and since World War II has kept production at a high level. In addition to the operations described below, several abandoned quarries and plants are described in previous

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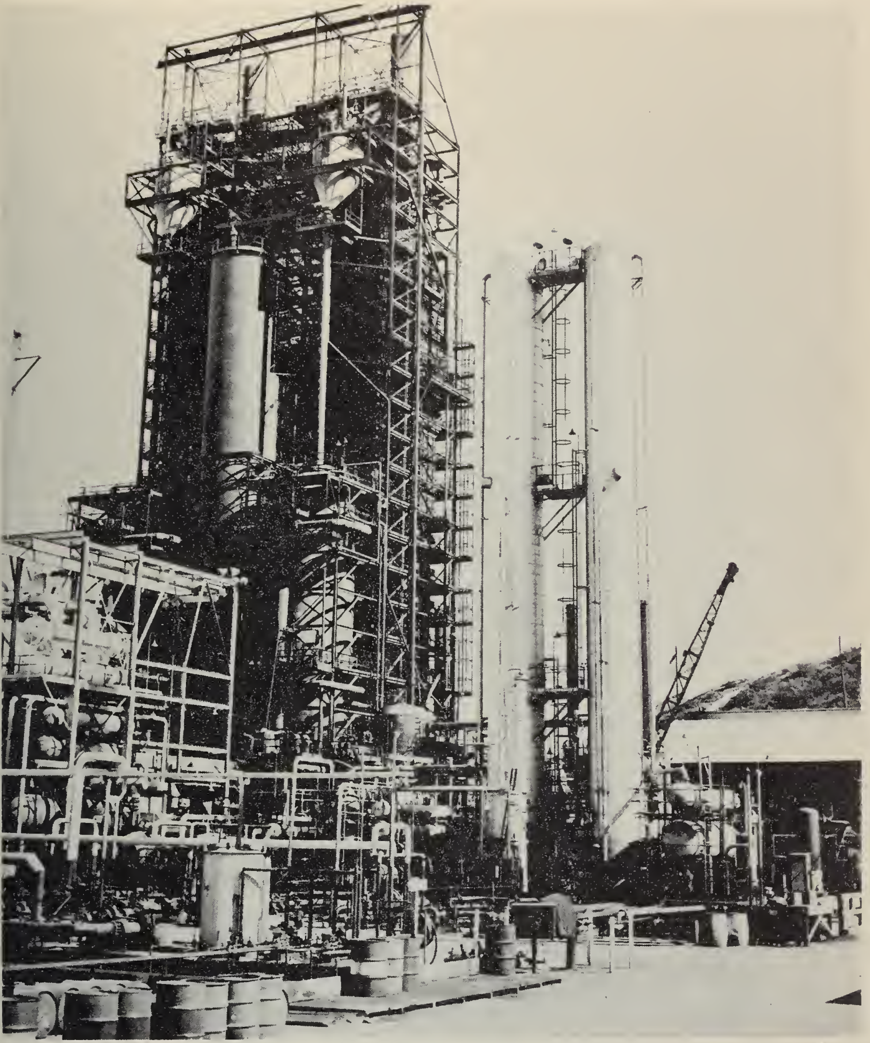
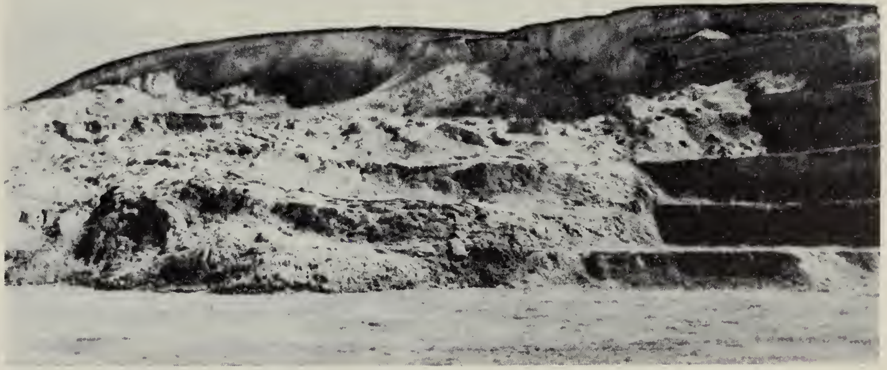
[32] Sampson, R. J., and Tucker, W. B., Feldspar, silica, andalusite, and cyanite deposits of California: California Div. Mines Rept. 27, pp. 436-437, 1931.



THERMOFOR CATALYTIC CRACKING TOWER
100-octane plant, Standard Oil Company of California, Richmond refinery.
Photo courtesy of Standard Oil Company of California.

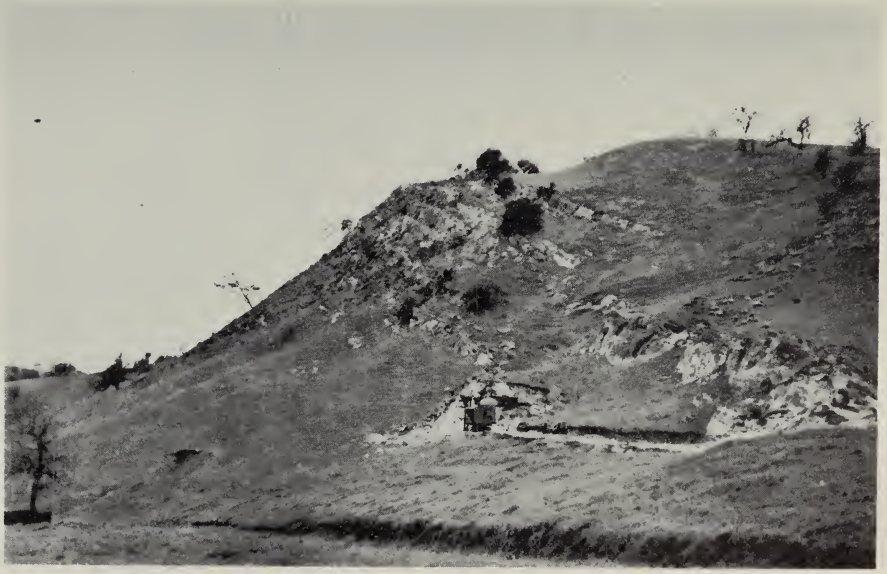
ROCK QUARRY AND PLANT AT UPTON
Henry J. Kaiser Company.



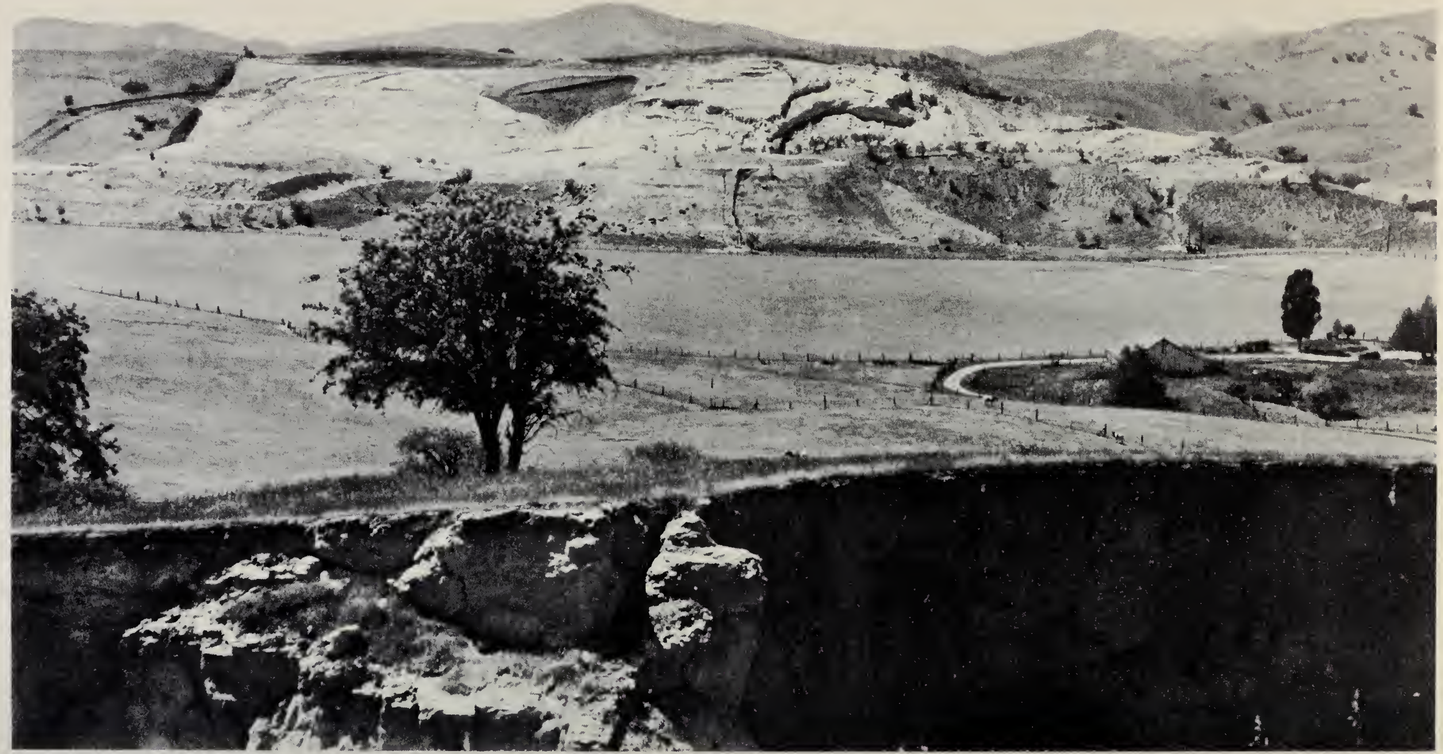
LANDSLIDES IN LOOSELY CONSOLIDATED SHALE, SANDSTONE, AND CONGLOMERATE OF PLIOCENE AGE

View south into fill-rock quarry near Port Chicago. Strata dip about 20 degrees toward the camera. Slides occurred during exceptionally wet winter of 1950-1951. Benches are about 15 feet high.

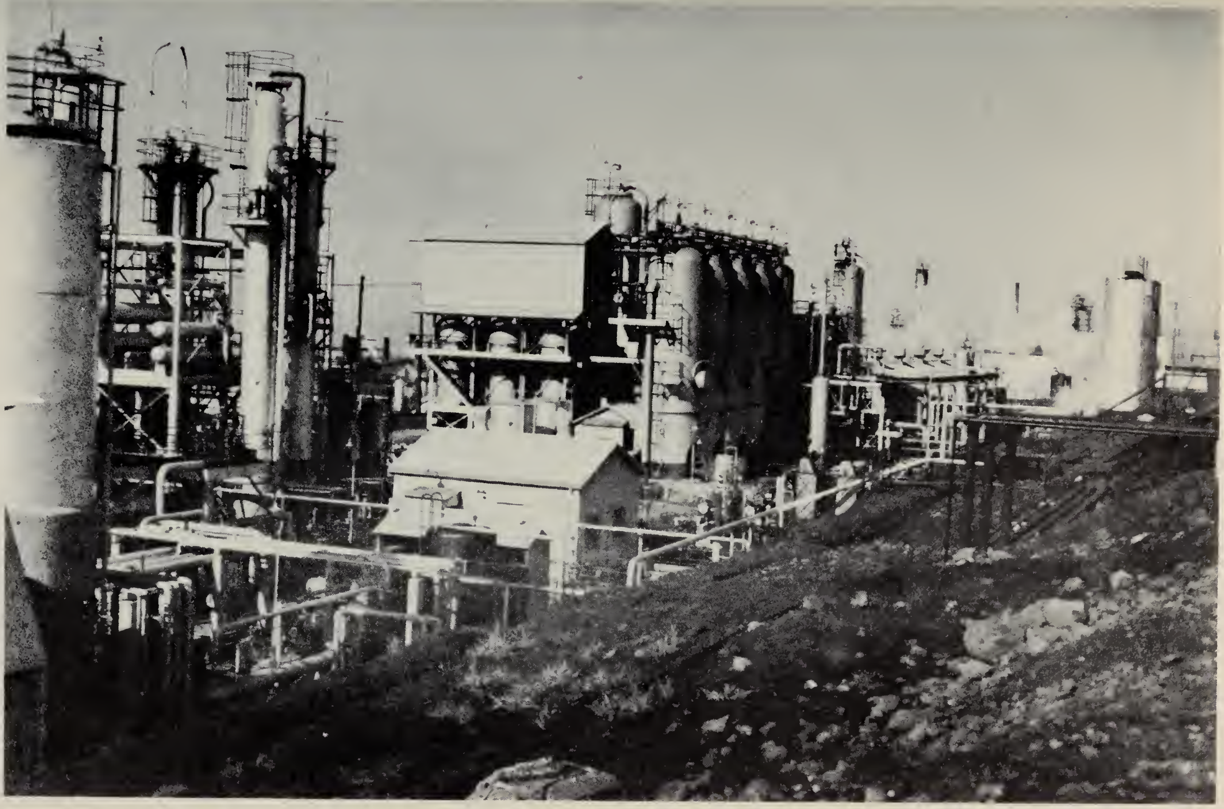
MOUNT DIABLO QUICKSILVER MINE, MOUNT DIABLO
North peak of Mount Diablo in background.



EOCENE SANDSTONE STRATUM
A source of foundry sand, north of Mount Diablo. Equipment of Marchio Sand Company in foreground.

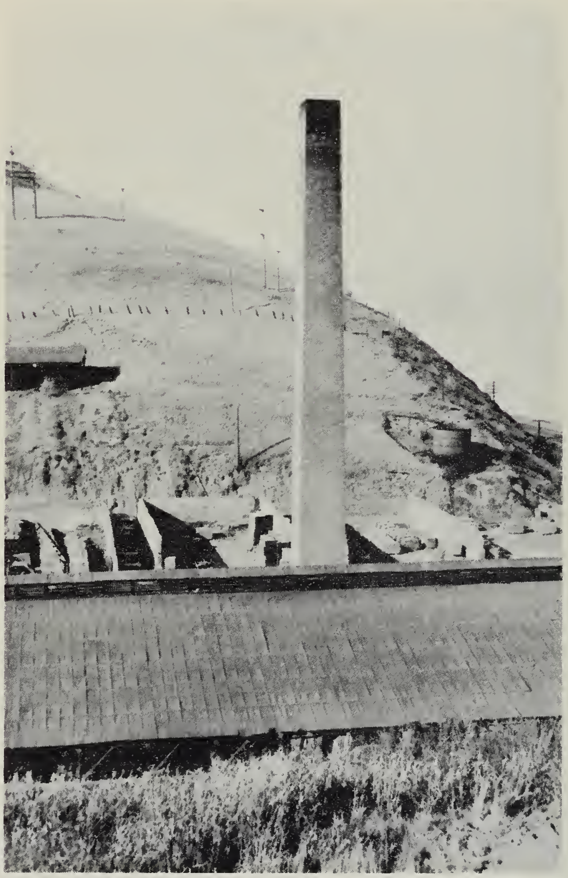


LONGWELL RANCH SAND PITS
View southwest toward South pit; caved stopes of North pit in foreground.
Photo courtesy of S. L. Longwell.



LUBRICANT DEWAXING PLANT

Union Oil Company of California, Oleum refinery. *Photo courtesy of Union Oil Company of California.*



PORT COSTA BRICK WORKS FIELD KILNS
Hoffman kiln is beneath roof in foreground.

reports. These operations were located at Point Richmond, Brooks Island, and along the bay side of the Berkeley Hills. Operation of the quarries in the Berkeley Hills was restricted by the encroachment of residential areas of Berkeley and El Cerrito.

At present the plants are processing rock of three types: hard sandstone from the Franciscan formation, basalt from the Pliocene Moraga formation, and sandstone from the Sobrante sandstone member of the Miocene Monterey group. The comparative wear resistance of these rocks as determined by the Los Angeles Rattler Test has been furnished by the California State Division of Highways. The tests were run to establish the suitability of these rocks for use in highway construction. Considering the results of the tests the basalt appears to be the most wear resistant, closely followed by sandstone of the Franciscan formation. Results of the tests are shown in table 8.

Table 8. Los Angeles Rattler Tests on Contra Costa stone.

Rock type	*Number of tests*	*Percent of wear after 500 revolutions*
Tertiary basalt	6	11.8–19.6
Franciscan sandstone	1	19
Tertiary sandstone	2	44 –97.4

N. M. Ball Sons. Location: sec. 25, T. 1 N., R. 2 W. (projected), on Shell Ridge in Walnut Creek, north of Walnut Drive. Ownership: F. A. Marshall, Danville.

This quarry was opened in May 1947 to supply crushed rock for driveways and fills in a subdivision developed by the above group of general contractors. No rock has been mined or crushed here since late 1947, although some shipments have been made from a stock pile which still contains about 10,000 tons. The abrasive resistance of rock produced here is too low to pass state specifications for use in buildings and highways. The rock is poorly consolidated sandstone and conglomerate of Tertiary age, containing as much as 50 percent sea shells. When the quarry was producing, the rock was loosened by blasting and a Caterpillar tractor with bulldozer pushed the broken rock to a receiving bin feeding a portable crusher. A conveyor belt moved the crushed rock to the stock pile from which it was loaded into trucks by a power shovel.

Blake Brothers (San Pablo). Location: sec. 15, 16, T. 1 N., R. 5 W. (projected), on Castro Point at Richmond-San Rafael ferry landing. Ownership: Blake Brothers, Box 1002, Richmond.

This operation, which began in 1907, now includes a quarry, rock crushing and sizing plant, storage bunkers, truck and barge-loading facilities, ready-mixed concrete plant, and hot asphalt plant.

The rock quarry is a large, steep-sided, circular-shaped open pit excavated in a Franciscan sandstone dipping steeply westward. Large blocks of quarry rock are broken up by dynamite charges placed in a grizzly adit (a small adit with crosscuts drifted into the quarry face at the level of the quarry floor). The adit is run from the quarry face a maximum distance of 60 feet. Crosscuts are then run at right angles to the adit a maximum distance of 100 feet in each direction. The adit and crosscuts are 4 to 5 feet in cross section. Dynamite charges are placed at 20-foot intervals in the crosscuts and part way out in the adit. Adit and crosscuts are then completely backfilled, and all charges are detonated simultaneously. In this manner, 500,000 tons of rock have been broken with one blast.

Fragments too large to be handled by power shovels are "bulldozed" (broken by secondary drilling and blasting). Rock is loaded into trucks by three steam shovels, having dippers of 2-cubic-yard capacity. The trucks dump into a crusher pit which contains a No. 12 Allis-Chalmers cone crusher. A grizzly is available when needed for sorting out larger fragments used as riprap. The material discharged from the primary crusher is minus eight-inch in size; it is conveyed to a bin from which trucks are loaded. Pneumatically controlled doors regulate flow of material into dump trucks. Trucks haul the rock to the plant receiving bins, a distance of about an eighth of a mile. Several stages of crushing and screening in the plant produce nine sizes of rock ranging from minus $\frac{1}{4}$-inch to 6 inches. Allis-Chalmers and Symons cone crushers are used in the plant. Sized rock is held in bins from which it can be drawn directly into trucks, or blended.

Two general types of rock are produced: the "blue" or clean grade, and the "second" grade which includes overburden and weathered sandstone. The "blue" rock is most acceptable for use in the ready-mixed concrete plant and the hot asphalt plant. It is withdrawn from piles by underlying tunnel conveyor belts. "Second" grade rock is also stored in large outdoor piles from which power shovels load directly to delivery trucks.

The capacity of the crushed rock plant is 1,500 to 1,600 tons per day. The asphalt plant has a capacity of 1,000 tons per day, and the ready-mixed concrete plant 400 to 500 yards per day. Blake Brothers own and operate a fleet of trucks to deliver concrete. Although some rock is shipped by rail, most of the production from this plant is shipped by truck. The company maintains barges and barge clamshell cranes for moving and unloading crushed rock and riprap to bay and river points. The barges are loaded by a conveyor belt and bin system which allows blending of rock sizes.

The most modern equipment available is used in the concrete and asphalt plant. In the concrete plant the raw materials are weighed separately and discharged into trucks, where they are mixed en route to the delivery point. In the asphalt plant the rock is heated in a rotary kiln; then weighed and mixed with steam heated asphalt. The hot mixture is discharged into waiting trucks.

Changes in the plant in the last few years include the addition of the ready-mixed concrete plant and the hot asphalt plant. It is anticipated that conveyor belts will be installed soon to move the rock from the quarry to the crushing plant.

Harrison-Birdwell. Location: secs. 14, 23, T. 1 N., R. 1 W., 1 mile south of Clayton on Mitchell Road. Ownership: G. Murchio, Brentwood. Leased to Harrison-Birdwell.

Operations began here in July 1947 and have been continuous since that time. Two quarries have been opened by this organization. The first one is in serpentine but work there was discontinued because a large area of soft rock was uncovered in the center of the quarry. Another quarry was opened in Franciscan sandstone less than a quarter of a mile south of the first quarry. It is a circular-shaped open cut in a small ravine. Holes 25 to 30 feet deep are drilled with pneumatic drills and loaded with 40 percent Hercules bag-powder. After shooting, the broken rock is loaded into dump trucks by a 1¼-yard capacity Osgood gasoline-powered shovel. One D-8 Caterpillar tractor is used in the quarry to move rock. Trucks dump broken rock into the receiving bin at the crushing plant which is located at the first quarry. The rock passes over a 2-inch grizzly before entering the jaw crusher (a 24- by 40-inch Cedar Rapids), powered by a Caterpillar diesel engine. The crusher reduces the rock to minus 3-inch size. Two rock sizes are produced by screening: 2- to 3-inch, and minus 2-inch. The former size is used for drain rock, and the latter for road beds. Trucks are loaded from a hopper, or from a stock pile by means of a Pawling & Harnischfeger gasoline-power shovel of ¾-yard capacity. Total daily capacity of crushed rock is 1000 tons.

Henry J. Kaiser Company. Location: secs. 3, 4, 9, 10, T. 1 S., R. 3 W., south of Tunnel road, at Upton, about 1 mile west of Orinda crossroads. Ownership: Henry J. Kaiser Company, 1924 Broadway, Oakland. The company officials are R. S. Barneyback, general manager; D. L. Wilbur, superintendent; and Marshal Gibson, engineer.

This rock quarry occupies the summit of a triangular-shaped knob on the south side of the tunnel road at an elevation of 1100 feet. The quarry is about 400 feet above the level of the tunnel road which separates the knob from San Pablo ridge. The surface rocks at the quarry were mapped by Lawson [33] as part of the Moraga formation of Pliocene age. The Moraga formation consists of andesite and basalt flows, rhyolitic and basic tuffs; lentils of gravel, clay, limestone, and beds of conglomerate occur near the base. Structurally, the quarry is on the eastern limb of the Siesta Valley syncline which tends northwestward. The beds are locally distorted and faulted making it difficult to mine a continuous bed in the quarry operations.

The quarry face is approximately 75 feet high by 300 feet long. At one point in the face the following sequence of rocks is exposed: pink andesite (top), red lateritic tuff, and basalt. The basalt provides the best crushed rock because it is dense, tough, and breaks into angular fragments. Toe holes are drilled in the face of the quarry and, after shooting, the fragmented material is loaded to two GMC 20-ton trucks using a model 80 Northwest shovel. The shovel is gasoline operated, caterpillar mounted, and digs with a 2½-cubic-yard dipper. The quarry rock is trucked about a quarter of a mile and dumped over a grizzly at the receiving end of the crushing plant.

Here the plus 6-inch rock passes to a 60-inch Allis-Chalmers jaw crusher for size reduction. The crusher discharge and the minus 6-inch rock from the grizzly is fed to a 4- by 18-foot inclined trommel where the minus 2½-inch rock is scalped out. The plus 4½-inch minus 6-inch rock is dropped to a 24-inch jaw crusher making minus 2½-inch material, while the plus 2½-inch minus 4-inch rock is run through a Seymour cone crusher and is reduced to minus 1-inch size. The products of both crushers are returned to the trommel and the minus 1½-inch rock falls to underlying screens where the following products can be made: plus ¾-inch to minus 1½-inch, plus ½-inch to minus ¾-inch, plus ¼-inch to minus

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[33] Lawson, Andrew C., op. cit., 1914.

½-inch, plus ⅛-inch to minus ¼-inch, and minus ⅛-inch. A series of conveyor belts conducts the screened rock to the appropriate stock pile. A model 5, Northwest shovel with a 1½-yard dipper is used for out-loading delivery trucks from quarry stock piles. All crushed rock is sold to truckers f.o.b. plant and is used as crusher-run base for road building.

The plant is electrically operated and requires a connected horsepower of 550 for its operation. The primary crusher alone requires about 200 horsepower. Fourteen men are employed on a 5-day week, working one shift from 8 a.m. to 4:30 p.m. daily. The rated capacity of the quarry and plant is 1200 tons of rock per day.

Serra Brothers (Slater). Location: sec. 34, T. 2 N., R. 2 W. (projected), a quarter of a mile south of Pacheco on the Pacheco-Walnut Creek road. Ownership: C. C. Slater, Route 1, Box 369, Martinez. Leased to Serra Brothers, Route 1, Box 335, Martinez.

This quarry was opened in 1942 to provide fill for Buchanan air field across the highway to the east. The present operators obtained a lease on the quarry (about 5 acres) in 1946 and have been in continuous production since that time. At the time the lease was obtained by the present operators, there was sufficient broken rock in the quarry to support operations. Recently it has been necessary to blast to obtain more rock. The blasting has been done in benches 20 feet high. The quarry is in moderately well consolidated sandstone with some areas of shale. The sandstone satisfies the state's requirements for highway work and most of the rock is employed for this purpose. A D-7 Caterpillar tractor with bulldozer is used to push the broken rock into a receiving bin. The rock from this bin passes over a grizzly and into a 15- by 38-inch Pacific jaw crusher which is usually set to produce 3- to 4-inch rock. The discharge from the grizzly and the crusher is received on a conveyor belt which transfers it to a truck-loading hopper. The maximum output per 8-hour day is 800 tons. A load of 90 electrical horsepower is connected in the crushing plant. Two men are employed. Crushed rock is sold for $0.90 to $1.00 per ton at the plant. Ground level drive-on scales are provided for weighing.

Mineral Fuels

Asphalt

Asphalt production recorded for Contra Costa County in 1907, 1908, and 1909, came from the early oil refineries of the county. However, ''seepages of heavy black asphaltic oil'' have been noted on Lauterwasser Creek, and in the lower end of San Pablo Valley, 2 miles east of San Pablo.[34]

Coal

Coal was discovered about 1852 in Contra Costa County and the deposits were worked in a small way in 1855.[35] The coal beds, in what is called the Mount Diablo field, crop out in the northern foothills of Mount Diablo in an arclike pattern, crossing the northern part of T. 1 N., R. 1 E., and the northwestern and central parts of T. 1 N., R. 2 E., a distance of 10 to 12 miles. The deposits are 5 to 6 miles south of Pittsburg and Antioch. Extensive development of the mines followed the construction

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[34] Vander Leck, Lawrence, Petroleum resources of California: California Div. Mines, Bull. 89, p. 61, 1921.

[35] Bancroft, H. H., History of California: 1860-1890: vol. 7, p. 661, The History Company, San Francisco, 1890.

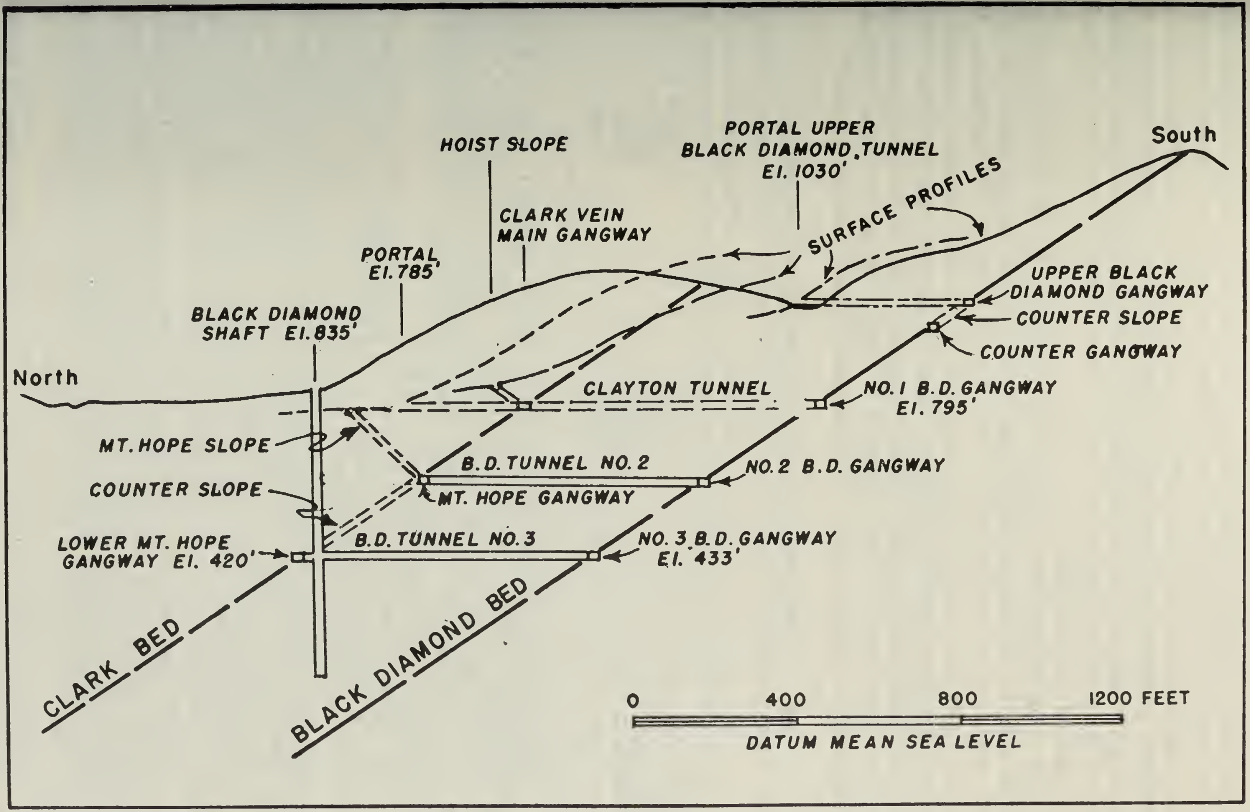
South
North
PORTAL UPPER
BLACK DIAMOND TUNNEL
El. 1030'
HOIST SLOPE
CLARK VEIN
MAIN GANGWAY
PORTAL
El. 785'
BLACK DIAMOND
SHAFT El. 835'
SURFACE PROFILES
UPPER BLACK
DIAMOND GANGWAY
COUNTER SLOPE
COUNTER GANGWAY
CLAYTON TUNNEL
NO. 1 B.D. GANGWAY
El. 795'
MT. HOPE SLOPE
B.D. TUNNEL NO. 2
NO. 2 B.D. GANGWAY
COUNTER SLOPE
MT. HOPE GANGWAY
LOWER MT. HOPE
GANGWAY El. 420'
B.D. TUNNEL NO. 3
NO. 3 B.D. GANGWAY
El. 433'
CLARK BED
BLACK DIAMOND BED
0
400
800
1200 FEET
DATUM MEAN SEA LEVEL

FIGURE 2. North-south vertical section through the Black Diamond shaft of the Black Diamond coal mine, Contra Costa County. Workings shown by broken lines are projected to section. *Section by courtesy of Southport Land and Commercial Company.*

of two railroads into the coal field in the middle 1860's from New York Landing and Pittsburg Landing at tidewater. Peak production was reached in the 1870's and 1880's. From 1868 to 1886 about 2,500,000 tons of coal were produced, an average yearly production of more than 160,000 tons. Output declined sharply at the turn of the century and finally ceased in 1902. At one time 1000 miners were employed. The chief mining settlements were Nortonville and Somersville. Competition from petroleum products and imported high-ranking coal forced cessation of coal output from the Mount Diablo field. Although production statistics are incomplete, indications are that about 3,500,000 tons of coal have been taken from the field.

The coal beds of the Mount Diablo field are in the Domengine formation, a series of Eocene sedimentary rocks. These rocks dip 12° to 35° north both at the surface and at the depths reached by the mines. In general the surface coal is deeply weathered, and the coal improves downward to 200 feet below the surface. The two principal coal beds of the area, the Clark bed and the Black Diamond bed, have been classed as sub-bituminous by the United States Bureau of Mines.[36] Table 9 shows typical analyses of coal from the Clark and Black Diamond beds.[37]

Table 9. Analyses of coal from Clark and Black Diamond beds.

	Clark bed	Black Diamond bed
Specific gravity	1.3539	1.4150
Moisture	11.64	13.015
Volatile matter	47.365	42.15
Fixed carbon	34.43	35.235
Ash	6.645	10.600

The Clark bed is 1½ to 4½ feet thick, and is generally free of interstratified undesirable material. However, at the thicker portions of the bed an overlying clay bed, as much as 2½ feet thick, caused some mining difficulties. Workings on the Clark bed extend along its entire length, some workings reaching a depth of 710 feet.

The Black Diamond bed is by far the largest deposit in the field. It is 375 feet stratigraphically below the Clark bed and ranges from 6 to 18 feet thick, including considerable interstratified clay, slate, and impure slaty coal. In general the best coal from the Black Diamond bed is superior to the coal from the Clark bed, but it was more expensive to mine. A detailed description of the Mount Diablo field was prepared by Goodyear.[38]

The underground workings of the coal mines in the county are inaccessible, except parts of the old Black Diamond mine (Nortonville) and parts of the Pittsburg mine at Somersville. Some openings at these mines were maintained by the Roberts Sand Company and the Pittsburg Sand Co. for mining clay-free foundry sand and glass sand, respectively.

The principal mines of this field are located on the map and are included in the tabulation of mines accompanying this report.

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[36] Analyses of Arizona, California, Idaho, Nevada and Oregon coals: U. S. Bur. Mines, Tech. Paper 696, 1947.

[37] Peckham, S. F., Chemical examination of Pacific Coast coals: Geology, the Coast Ranges, vol. 2, Appendix E, pp. 41-48, Cambridge, Massachusetts, 1882.

[38] Goodyear, W. A., The coal mines of the western coast of the United States: San Francisco, A. L. Bancroft & Co., pp. 6-66, 1877.

Natural Gas and Petroleum

At present, seven wells are producing dry natural gas in Contra Costa County, all within the Rio Vista gas field, which embraces 21,770 acres in three counties. Of this area, 953 acres are in Contra Costa County, the remainder lying in Sacramento and Solano Counties. At least 35 wildcat wells have been drilled in Contra Costa County.

The first well drilled for oil in Contra Costa County—the second to be drilled in the state—was drilled in 1862 on the west side of San Pablo Creek, 4 miles southeast of San Pablo.[39] In 1864 a well was drilled near oil seeps on the northeast flank of Mount Diablo probably in sec. 24, T. 1 N., R. 1 E., 1½ miles south of the old Empire coal mine. Several barrels of green-colored oil of high specific gravity were obtained from a depth of 300 feet from beds of undetermined age. Similar success was obtained by other wells in this area.

In the lower San Pablo Valley, about 3 miles east of San Pablo, five wells were drilled into the Orinda formation (Pliocene) near seeps of black asphaltic oil.[40] Some oil and gas was encountered but commercial production was not established.

Traces of petroleum were obtained by wells drilled in the so-called Miner Ranch oil field on Lauterwasser Creek, 1 mile north of Orinda. A report on this field was prepared by Arnold in 1907 [41]. At that time eight wells had been drilled, all on the southside of Lauterwasser Creek. The wells ranged in depth from 570 to 2750 feet, being drilled in the northeast flank of the Miner Ranch anticline. The anticline trends and plunges southeast, crossing the creek about a mile northeast of Orinda, and is truncated on the northwest by a fault. Oil accumulations found in the anticline are in the sandy beds of the Orinda formation, which is underlain by shale beds of the Monterey series (Miocene). Gas was encountered in all wells and oil in some. One well is said to have produced 300 barrels of low-specific gravity oil from a depth of about 1300 feet. Gas from the field has a calorific value in excess of 1000 British thermal units, according to Arnold. Arnold concludes that future drilling in this area should expect results similar to those previously obtained.

In 1930-31 the Orinda Petroleum Company, Ltd., drilled a test on the Glorietta anticline 1 mile south of Orinda in sec. 32, T. 1 N., R. 3 W. Gas pressures of 240 pounds were developed, and cores from 777 feet to the bottom were cut, but the test was abandoned at 3033 feet because the capacity of the drilling equipment had been reached.

The deepest test in Contra Costa County was drilled by the Tassajara Oil Corporation in sec. 9, T. 2 S., R. 1 E., in 1938 and 1940. This test hole, which had a total depth of 9777 feet, encountered tight oil sands from which production could not be obtained. The test was located on a surface fold.

The Rio Vista field has been described by Frame [42]. The field was discovered in 1936 by the American Petroleum Corporation. Wells penetrate sediments which range in age from Recent alluvium to Cretaceous. The structure of the field is a broad northwestward trending, faulted, elongated dome. The northwest-striking Midland fault divides the field into two parts. Five productive zones in Eocene sediments have been encountered at depths ranging from 3900 to 5800 feet. The Emigh zone is the most productive; west of the Midland fault it is several hundred feet deeper than on the east side of the fault. The deepest well in the field penetrated 11,051 feet, bottoming in Cretaceous. It is estimated that the field originally contained 3,536,793,000 thousand cubic feet of gas. At the end of 1949 reserves were estimated to be 2,016,480,305 thousand cubic feet. During 1948 the field produced 138,977,851 thousand cubic feet, of which 332,379 thousand cubic feet came from the wells in Contra Costa County. The heat content of the gas from this field is high (1,040 British thermal units per cubic foot) compared with other dry natural gas fields in the state. During the last half of 1948, the field had 143 potentially productive wells; of these 131 were actually producing [43].

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[39] Whitney, J. D., Report of progress and synopsis of field work, from 1860 to 1864: California Geol. Survey, p. 12, 1865.

[40] Vander Leck, Lawrence, op. cit., pp. 60-61, 1921.

[41] Arnold, Ralph, The Miner Ranch oilfield, Contra Costa County, California: U. S. Geol. Survey Bull. 340, pp. 339-342, 1908.

[42] Frame, R. G., Rio Vista gas field: California Oil Fields, California Div. Oil and Gas, Summary of Operations, vol. 30, no. 1, pp. 5-14, 1944.

Producing and non-producing wells in the Contra Costa County end of the Rio Vista gas field are listed in table 10 and are also shown on plate 42. A map of the Rio Vista gas field [44] has been published by the California Division of Oil and Gas.

Table 11 lists the dry holes drilled in Contra Costa County outside of the Rio Vista gas field.

Table 10. Wells in the Contra Costa County end of the Rio Vista gas field.

Wells are owned by the Standard Oil Company of California.
Location: T. 3 N., R. 3 E., M. D.

Map number	Section	Wells
48	20	Bradford Community 1
49	20	Bradford Community 2
50	20	Bradford Community H-3
51	21	Bradford Community 4
52	20	Bradford Community 5
53	29	Jordan Unit 1
54	29	Jordan Unit 2*
55	29	Jordan Unit 3
56	23	Productive properties 1*
57	28	Productive properties 2*

* Uncompleted well.

Peat

Most of the delta area of the Sacramento and San Joaquin Rivers is underlain by peat. These deposits cover an estimated 432 square miles, about one-sixth of which is in Contra Costa County. Most of the land northeast of the Santa Fe Railway in the northeast corner of the county is peat land.[45] The deposits are believed to attain a maximum thickness of 80 feet. However, the deposits are most commonly less than 20 feet thick. Contra Costa is the leading peat producing county of the state.

Peat is the residuum resulting from the arrested decomposition of vegetal matter that accumulates in water-covered or swampy land. Peat

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[43] Bush, R. D., Resumé of oil field operations in 1948: California Oil Fields, California Div. Oil and Gas, Summary of Operations, vol. 34, no. 2, p. 20, 1948.

[44] Oil and gas field map 57—Rio Vista gas field, California Div. Oil and Gas, 1950.

[45] Laizure, C. McK, Notes on peat and its occurrence in California: California Min. Bur. Rept. 19, p. 103, 1923.

Requa, M. L., and others, Fuel resources of California: Commonwealth Club of San Francisco, Trans., 1912.

Table 11. Wells (dry holes) outside Rio Vista gas field.

Map no.	Location				Company and well	Date begun	Date abandoned	Depth in feet	Geology at bottom of hole
	T.	R.	Sec.	B.&M.					
	*2N	4W	29	MD	Point Richmond Oil Co.—two wells	1900	---	100	
	*2N	4W	29	MD	Sobrante Oil & Investment Co.	---	1900	---	
66	2N	3W	21	MD	Standard Oil Co. of California: Fernandez Community 1	1948	1948	6,607	Eocene
59	2N	2W	31	MD	Edwards, Wm.: No. 1	---	pre-1925	2,224	Monterey
58	2N	1W	21	MD	Cal-Bay Corp.: Faria 1	1943	1945	4,975	Eocene
67	2N	1W	26	MD	Standard Oil Co. of California: Keller 1	1943	1943	4,133	Cretaceous
72	2N	3E	4	MD	Trico Oil & Gas Co.: Trico Signal 1	1943	1943	4,350	Eocene
71	2N	3E	9	MD	Tide Water Associated Oil Co.: Bethel Is.; Community 1	1942	1942	4,975	Eocene
	*1N	4W	5 or 6	MD	San Pablo Oil Co.	---	1900	670	
	*1N	4W	8	MD	Mount Diablo Oil Co.—several wells	---	---	170	
	*1N	4W	?	MD	Unnamed	---	---	87	
68	1N	3W	6	MD	Standard Oil Co. of California: Oursan Community 1	1943	1944	4,270	Cretaceous
64	1N	3W	13	MD	Shell Oil Co.: East Bay 1	1944	1945	8,480	Chico?
61	1N	3W	26	MD	Leachman and Marshall: No. 1	---	1926	450	Monterey
73	1N	3W	27	MD	Unnamed—eight wells	---	pre-1907	(570 to 2,750)	Monterey shale
	*1N	3W	27	MD	Tide Water Oil Development Co.	---	1904	300	
63	1N	3W	32	MD	Orinda Petroleum Co., Ltd.: No. 1	---	1931	3,033	
	*1N	3W	32	MD	Grand Pacific Oil Co.—one or more wells	---	---	---	
	*1N	3W	33	MD	Central California Oil Co.: Old Flood 1	---	pre-1925	1,640	Monterey
60	1N	2W	28	MD	Lafayette Oil Co.: Morris 1	1941	1941	1,580	
	*1N	2W	28	MD	National Paraffin Co.	1900	---	1,694	
	*1N	1E	15	MD	Harding well	---	pre-1936	978	
	*1N	1E	15	MD	Atlas Development Co.: No. 1	---	pre-1921	1,823	
65	1N	2E	4	MD	Shell Oil Co.: Heidorn 1	1944	1944	4,048	Middle Eocene
62	1N	3E	30	MD	Ohio Oil Co.: Brentwood Farms 1	1948	1948	5,456	Eocene
69	1S	3E	14	MD	Standard Oil Co. of California: Sproule 1	1949	1949	6,070	
	*2S	1W	25	MD	Brady Sure Shot Oil Co.: No. 1	---	(1925 to 1926)	300	Miocene
70	2S	1E	9	MD	Tassajara Oil Corp.: Rasmussen 1	1939	1940	9,777	Miocene

* Not shown on map.

in the delta area of the San Joaquin and Sacramento Rivers is composed primarily of partly decomposed and disintegrated mosses, tules, and grasses. The carbonaceous matter in these plants is preserved because of the deficiency of oxygen below the water level in the lakes and marshes. Most of the peat in this area is classified by commercial standards as sedge or tule peat, an intermediate grade between high grade peat moss and inferior peat dirt. Some peat dirt is also produced in the delta area. Much of the land containing peat is used for agricultural purposes.

California Peat Company. Location: secs. 1, 2, 11, 12, T. 2 N., R. 3 E., M.D., in Frank's Tract. Ownership: California Peat Company, Box K, Antioch.

At present (October 1950) no peat is being produced. When operating, the California Peat Company dredges peat from a 2600-acre holding, embracing several sections in the northeastern part of T. 2 N., R. 3 E. These sections lie in Frank's Tract, an area now covered by 6 to 8 feet of fresh water, but which formerly was farm land protected by levees. In 1937 the area was flooded by a levee break on the Bethel Island (southwest) side. The company dredges the peat with a 1-cubic yard clamshell dredge mounted on a barge. The peat is loaded into barges for transfer to the drying yard immediately west of the south approach to the Antioch highway bridge. Here, the peat is sun-dried and its density reduced from about 1800 pounds per cubic yard to about 700 pounds per cubic yard. After drying, the peat is shredded by revolving knives in a converted grain harvester which will handle up to 50 tons per hour. According to the operator, Mr. Cunningham, the peat deposit is known to be at least 17 feet thick, reserves are tentatively estimated to be 25 million cubic yards.

Most of the peat produced here has been sold to nurseries for use in potted plants, and for compounding fertilizer for resale.

A typical chemical analysis of the peat provided by the operator is shown in table 12.

Table 12. Chemical analysis of peat—California Peat Company.

	10% moisture basis
Total nitrogen (N)	1.77%
Total potash (K_2O)	0.04
Total phosphoric acid (P_2O_5)	0.16
Sodium chloride (NaCl)	0.04
Ash (mineral matter)	10.83
Moisture at 100° C.	10.00
Organic matter	79.17

MINERAL PROCESSING INDUSTRY

Metallic Ores

American Smelting and Refining Company, Selby lead smelter. Location: Selby, at tidewater north of U. S. Highway 40, about 2 miles west of the Carquinez Bridge. Ownership: American Smelting and Refining Company, 405 Montgomery Street, San Francisco.

The Selby smelter was established in 1883 by Tom Selby, a San Francisco shot-maker, who had expanded into the business of smelting western lead ores. His first blast furnace, which treated a half a ton of ore, was blown-in in 1885. From this early beginning, the smelter has

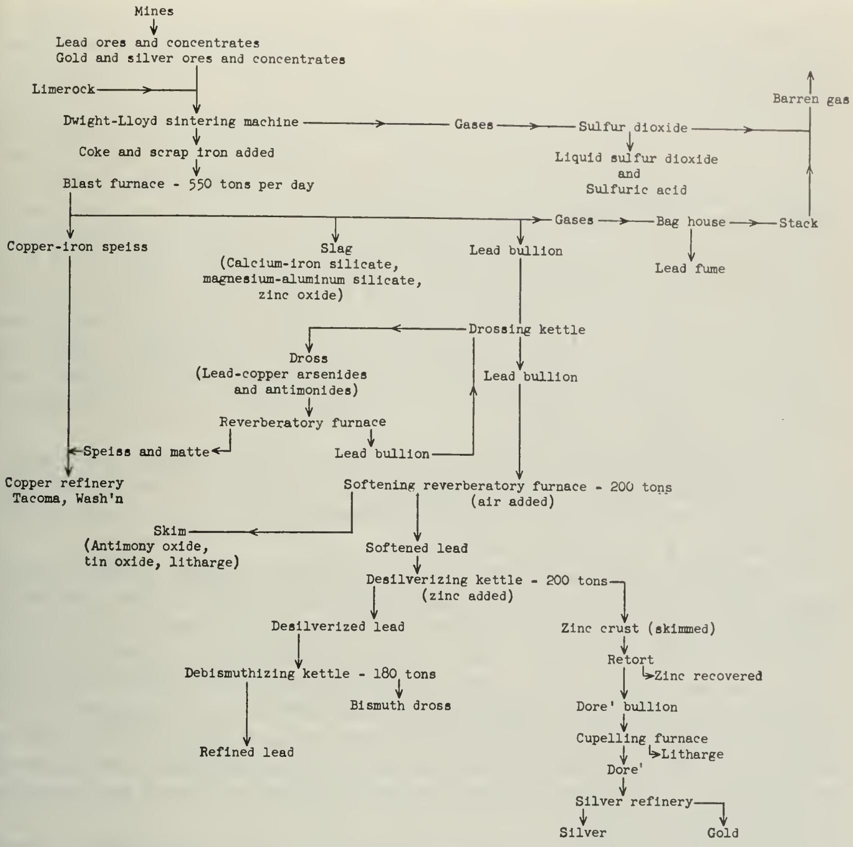
Mines
Lead ores and concentrates
Gold and silver ores and concentrates
Limerock
Dwight-Lloyd sintering machine
Gases
Sulfur dioxide
Barren gas
Liquid sulfur dioxide and Sulfuric acid
Coke and scrap iron added
Blast furnace - 550 tons per day
Gases
Bag house
Stack
Lead fume
Copper-iron speiss
Slag (Calcium-iron silicate, magnesium-aluminum silicate, zinc oxide)
Lead bullion
Drossing kettle
Dross (Lead-copper arsenides and antimonides)
Lead bullion
Reverberatory furnace
Speiss and matte
Lead bullion
Copper refinery Tacoma, Wash'n
Softening reverberatory furnace - 200 tons (air added)
Skim (Antimony oxide, tin oxide, litharge)
Softened lead
Desilverizing kettle - 200 tons (zinc added)
Desilverized lead
Zinc crust (skimmed)
Retort
Zinc recovered
Debismuthizing kettle - 180 tons
Bismuth dross
Dore' bullion
Cupelling furnace
Litharge
Dore'
Refined lead
Silver refinery
Silver
Gold

FIGURE 3. Flow sheet, Selby lead smelter, American Smelting and Refining Company.

been enlarged to its present capacity of 20,000 tons of charges per month, and receives shipments of ore and concentrates from all over the world. It smelts gold-silver and lead ores and concentrates and refines impure dredge gold, gold precipitates from cyanide mills, and scrap gold obtained from precious metal dealers. The lead sulfide concentrates receive a preliminary roasting to eliminate the sulfur and convert them into oxides. The oxides mixed with gold ores are reduced in a blast furnace to relatively pure metallic lead.

Ores from the western states, South America, Australia, and the Philippines are received by motor truck, rail, or water. They are unloaded into bins, trucked to the scale-house for weighing and sampling, and then stock piled. Most of the shipments are in the form of concentrates from gravity or flotation mills, but some shipments of high-grade ore from small mines are also received. The shipments range in size from a truckload containing 2 to 5 tons of ore, through a carload containing 30 to 50 tons of ore or concentrates, to a shipload of 10,000 tons. The purchase of small lots of ore and immediate payment for them has been helpful to the small producer.

The concentrates received at the smelter are usually too fine for charging directly to the furnace. It is therefore necessary to combine or agglomerate the particles into fragments ranging from 1 inch to 6 inches in size. This is done in a Dwight-Lloyd sintering machine. Prior to sintering, the stock pile concentrate is first delivered to one of 12 mixing bins. Here water is added and the resulting mass is dropped through pan feeders to a proportioning belt leading to the machines. In sintering, the charge on the sinter pallet is given a preliminary flash firing to ignite the mass and is then downdraft blast-fired to burn off the sulfur as sulfur dioxide gas. The sulfur content of the sinter charge is reduced from about 12 to 5 percent in the first pass through the Dwight-Lloyd machine. The sinter cake is discharged in large fragments, again crushed to a fine particle size, and sent through a second Dwight-Lloyd machine where the sulfur content is reduced to about 1.8 percent. The sinter fragments discharged from the second machine are ready for smelting. They are delivered to a furnace charging car, coke and scrap iron are added, and the car is elevated vertically to the charging floor of the blast furnace about 50 feet above ground level.

In the blast furnace the charge is heated to the point where a number of reactions take place. The metallic lead trickles downward through the furnace and is collected in the lead well from which it is periodically withdrawn in a fiery red stream.

Gold-silver and lead ores and concentrates usually contain small quantities of numerous other metals which are reduced with the lead. Copper, arsenic, antimony, tin, and bismuth are therefore present as impurities in the unrefined lead and may constitute 10 percent of the total. The lead bullion from the blast furnace is received in iron pots of approximately 4-ton capacity and transferred to a drossing kettle. Here the metal is held at a low temperature and agitated with air to oxidize part of the impurities which float to the surface and are skimmed off. This skimmed product, dross, consists primarily of lead-copper arsenides and antimonides.

The dross is treated in a reverberatory furnace which produces lead bullion, a high-copper speiss, and a low-copper matte. The lead bullion is returned to the drossing kettles. The high-copper speiss which contains approximately 60 percent copper, and the matte which contains 12 to 20 percent copper, are shipped to the company's copper refinery at Tacoma, Washington. The drossed lead is pumped to a second kettle and allowed to cool to the freezing point; it is reheated and the remaining copper taken off as a dross. The resulting bullion is cast into 5-ton blocks for transfer to the refinery. The metals of iron, calcium, zinc, aluminum, and magnesium which were present as gangue in the original ore, remain oxidized and combine with the silica to form slag, which is tapped through the fore-hearth to slag cars and trammed to the slag dump. Zinc is an undesirable metal in ores shipped to a lead smelter since it requires fluxing and is usually penalized if present in quantities above a specified minimum percentage.

A portion of the copper in the ore combines with the iron and the arsenic in the blast furnace to form a copper-iron speiss containing 10-12 percent copper. This product is separated in the fore-hearth of the furnace and is also shipped to the copper refinery at Tacoma.

Lead bullion from the smelting department still contains gold and silver, and impurities such as arsenic, antimony, tin, and bismuth. These impurities, especially antimony, make the lead hard. The first step in the refining process consists of removing the antimony and tin by oxidation and is therefore known as softening the lead. Softening is done in a 200-ton reverberatory furnace. The antimony, tin, and some lead oxide, rise to the surface and are skimmed off. When the lead is completely softened, it is ready for desilverizing, and is pumped to desilverizing kettles of 200-ton capacity.

Silver and gold are recovered from the lead bullion by the Parkes process. Zinc, which has a strong affinity for silver and gold, is added to the liquid lead bullion and mechanically ''stirred in.'' The zinc, silver, and gold form compounds which have high melting points and lower specific gravities than the lead bullion. Consequently, the zinc containing gold and silver floats to the top of the kettle as a crust and is removed by skimming. This zinc crust is placed in a press to remove most of the entrained lead and is then sent to the silver refinery. Here the zinc crusts are placed in a retort and the zinc is recovered by distillation. The residue metal consists of a high grade lead bullion which is treated in a cupelling furnace to remove the lead. The lead is oxidized to litharge and drained off, leaving a doré bullion of gold and silver which is cast into anodes. These anodes are treated electrolytically for the separation or parting of gold and silver by the Moebius process. Silver is recovered at the cathode in the form of crystals and the gold is recovered as a black sludge, which is treated with sulfuric acid for purification, after which it is treated by the Wohlwill process for production into refined gold. The desilverized lead is treated by the Betterton process for the removal of bismuth, and is then cast into 100-pound pigs.

The smelter gases are conducted through a bag house for the recovery of lead fumes. The fumes are cooled and then filtered in long woolen bags. The bags are shaken periodically and the dust and fume is collected at the bottom. The barren gases are conducted to the exhaust stack. The stack, second tallest in the world, is 605 feet 9 inches high and is an easily recognized landmark. Part of the gases from the sintering machines are high in SO_2 content and are conducted to a plant for the manufacture of sulfuric acid. Acid is made by the contact process at the rate of about 40 tons per day. Liquid sulfur dioxide is also produced.

During February 1951 the plant was being operated 24 hours a day, 7 days a week, and 535 men were employed.

Mineral Wool

Richmond Rock Wool Company. Location: Richmond. Ownership: Richmond Rock Wool Company, 1050 Road 17, Richmond. H. H. Huitt is manager. The plant which began operations in April 1946, originally used iron slag from the blast furnace at Fontana. Late in 1947, Mr. Huitt acquired control of the slag dump at the Penn copper mine in Calaveras County, which is estimated by him to contain 500,000 tons of slag. It is trucked to the Richmond plant by contract as minus 3-inch size material.

The slag, loaded into a water-jacketed foundry-cupola fired by Utah coke, is liquefied at a temperature of about 2600° Fahrenheit. The liquid slag trickles to the bottom of the cupola and drops onto an underlying jet of high-pressure (100-pounds per square inch) steam provided by a 125-horsepower boiler. The steam stream cools the liquid rock and blows it into flexible threads which are caught by a conveyor. A small percentage of glass beads or shot are formed. These beads are removed by two inclined rotary screens, and the rockwool is then ready for the bagging machine. All the production is put up in 40-pound bags and is usually sold in carload lots. The plant operates 24 hours a day and has a production capacity of 25 tons per day.

Perlite

American Perlite Corporation, perlite expanding plant. Location: Richmond. Ownership: American Perlite Corporation, C. W. Millen, manager, 26th Street south of Hoffman Boulevard, Richmond.

Crude Nevada perlite is crushed and ground to 14-mesh size at the quarry and shipped to the plant in gondola cars. At the plant it is conveyed and elevated to steel crude storage bins. The perlite is expanded in a gas fired, counter current vertical furnace. The expanded perlite is classified by air and separated into three sizes. Perlite plaster sand is in the minus 14 plus 100-mesh size range. A product suitable for filtering ranges from minus 50 to plus 200 mesh. The fines have possible uses as fillers. The plaster aggregate is elevated to the screen section of the plant and is sub-graded for specific uses.

Petroleum Refining

The numerous strategic advantages which this county offers to the refiner has made it the center of petroleum refining in northern California for over 50 years. At the refinery, crude petroleum is separated into its component parts, blended, and manufactured into numerous products.

In the early days of petroleum refining, the crude oil was piped into horizontal shell stills. Heat was applied to the outside of the shell and the increase in temperature caused vaporization of the component parts or fractions of the crude as higher and higher temperatures (up to 550° Fahrenheit) were attained.

As the demand for products increased, the stills were operated in batteries, thus batch process stills were succeeded by continuous process stills. Later the thermal cracking process was discovered whereby more of the gasoline components could be separated at very high temperatures (1000° Fahrenheit) and pressures (900 pounds per square inch) from a gas-oil product obtained from the shell stills. Here molecules with numerous atoms were broken down or "cracked" into molecules with few atoms. Fractionating columns were added to the shell stills to improve product separation and these columns evolved into the present-day pipe still. The modern pipe still consists essentially of a furnace, a vertical fractionating column (about 150 feet or more in height), and a vacuum still. The crude oil is pumped through the furnace in pipe-coils and the fractions are separated and removed at various levels in the fractionating column or "bubble tower." The heavier product or residuum from the bottom of the column is transferred to an adjoining vacuum still where steam is introduced preparatory to the separation of additional products.

The use of catalysts in cracking became an important part of modern refining just prior to World War II. Their general effect was to reduce the heat and pressure required to produce the same (or greater) yield from basic stock. The catalysts include alumina, molybdena, and silica jel in pelletized form and were developed in response to the soaring demand for high octane fuel by the aviation industry. The use of catalysts has provided tremendous new horizons for petroleum in the fields of chemicals, plastics, and medicine.

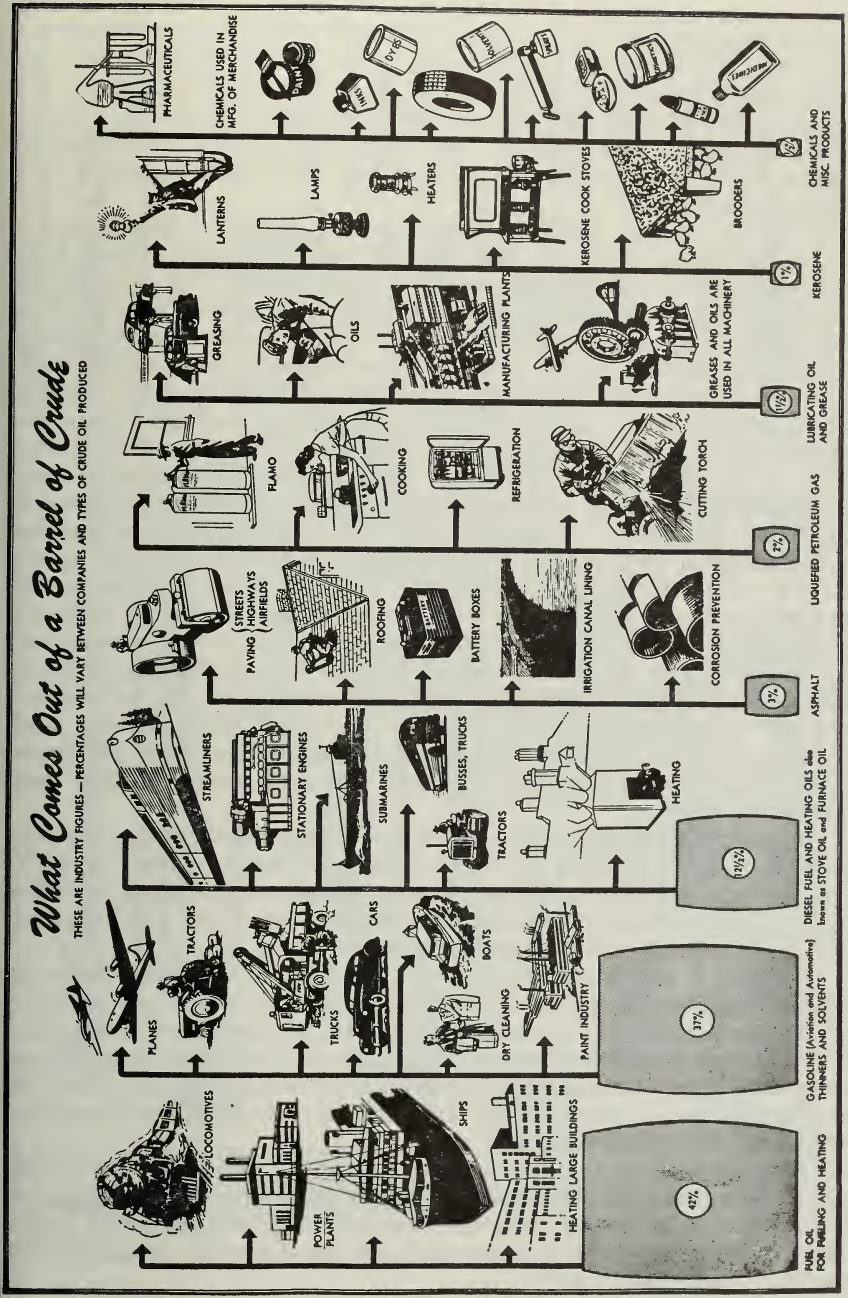
What Comes Out of a Barrel of Crude
THESE ARE INDUSTRY FIGURES — PERCENTAGES WILL VARY BETWEEN COMPANIES AND TYPES OF CRUDE OIL PRODUCED
LOCOMOTIVES
POWER PLANTS
SHIPS
HEATING LARGE BUILDINGS
42%
FUEL OIL FOR FUELING AND HEATING
PLANES
TRACTORS
TRUCKS
CARS
DRY CLEANING
BOATS
PAINT INDUSTRY
37%
GASOLINE (Aviation and Automotive) THINNERS AND SOLVENTS
STREAMLINERS
STATIONARY ENGINES
SUBMARINES
BUSSES, TRUCKS
TRACTORS
HEATING
12½%
DIESEL FUEL AND HEATING OILS also known as STOVE OIL and FURNACE OIL
PAVING
STREETS
HIGHWAYS
AIRFIELDS
ROOFING
BATTERY
BATTERY BOXES
IRRIGATION CANAL LINING
CORROSION PREVENTION
3%
ASPHALT
FLAMO
COOKING
REFRIGERATION
CUTTING TORCH
2%
LIQUEFIED PETROLEUM GAS
GREASING
OILS
MANUFACTURING PLANTS
GREASES AND OILS ARE USED IN ALL MACHINERY
1½%
LUBRICATING OIL AND GREASE
LANTERNS
LAMPS
HEATERS
KEROSENE COOK STOVES
BROODERS
1%
KEROSENE
PHARMACEUTICALS
CHEMICALS USED IN MFG. OF MERCHANDISE
PAINT
INKS
DYES
COSMETICS
MEDICINES
½%
CHEMICALS AND MISC. PRODUCTS

FIGURE 4. *Courtesy of Standard Oil Company of California.*

Standard Oil Company of California Refinery. Location: Richmond. Ownership: Standard Oil Company of California, 225 Bush Street, San Francisco. Ground was broken for this refinery in 1901, and in 1903 the first pipeline from the San Joaquin Valley oil fields to Richmond was completed. The pipeline carried crude oil to storage tanks at the San Pablo tank farm about 5 miles east of Point Richmond. At present the pipeline connects with the Kettleman Hills oil field in Fresno and Kings Counties (about 200 miles south), which supplies a crude oil averaging 35 degrees Baumé gravity. Occasionally foreign crude oil is brought to the refinery in tankers.

Crude oil from the well is furnace heated and fed to pipe-stills for the separation of stocks for gasoline, kerosene, thinners, diesel fuel, lubricating oil, and an abundance of feed stock (gas-oil) for the catalytic crackers. The Thermofor Catalytic Cracker, completed in 1944,[46] is higher than a 22-story building. Translucent beads of silica-jel, about an eighth of an inch in diameter, are the catalytic agent in this unit. The reactor tank holds a charge of 600 tons of beads, and the gravity flow of the charge is counter current to that of the feed stock from the furnace. The change in the gas-oil molecules occurs on the surface and in the pores of the beads. As a result of continued use, the catalyst receives an internal and external coating of carbon, which decreases its effectiveness. Since the catalytic agent is a high-cost item, a complex system for its regeneration or cleaning has developed. In this system the spent catalyst from the bottom of the reactor is bucket-elevated to the top of the regeneration tower. Here it is subjected to an alternating series of air-blasts and periods of water cooling, after which it is ready for re-use. The product from the ''cat-cracker'' is used to manufacture aviation gasoline, detergents, insecticides, high-octane additives for automotive fuel, and more gas-oil, which is recycled. The catalytic ''cracker'' and its allied processes, (including H-F alkylation), extract over five times as much high-octane product from one barrel of crude oil than was formerly possible.

A catalytic reforming plant, using molybdena pellets as the catalyst, was built in 1944. During World War II it produced toluene for TNT explosives and aviation gasoline. During peacetime it utilizes naphtha from the pipe-still and produces high-octane automotive gasoline, and basic ingredients for plastics and paint-thinners.

In 1949 a wax plant capable of producing 45,000,000 pounds of paraffin wax per year was constructed. The basic stock for wax production is separated at an intermediate point in the production of lubricating oil. This stock is reheated and sent to a rerun-distillation unit, where three wax ''cuts'' are separated on a basis of melting points. The cuts are then chilled, solvent-washed, and filtered; the resulting materials are high quality paraffin waxes.

A grease manufacturing plant and packaging warehouse was added in 1948. Raw materials are blended with petroleum stocks to manufacture lime-alumina-soda-base greases, compounding oils, and specialty products, by either batch or continuous processes. Capacity is 38,000,000 pounds of lubricants yearly.

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[46] Standard Oil Bull., January 1950.
Petroleum Town, Standard Oil Company of California, July 1950 (a booklet).

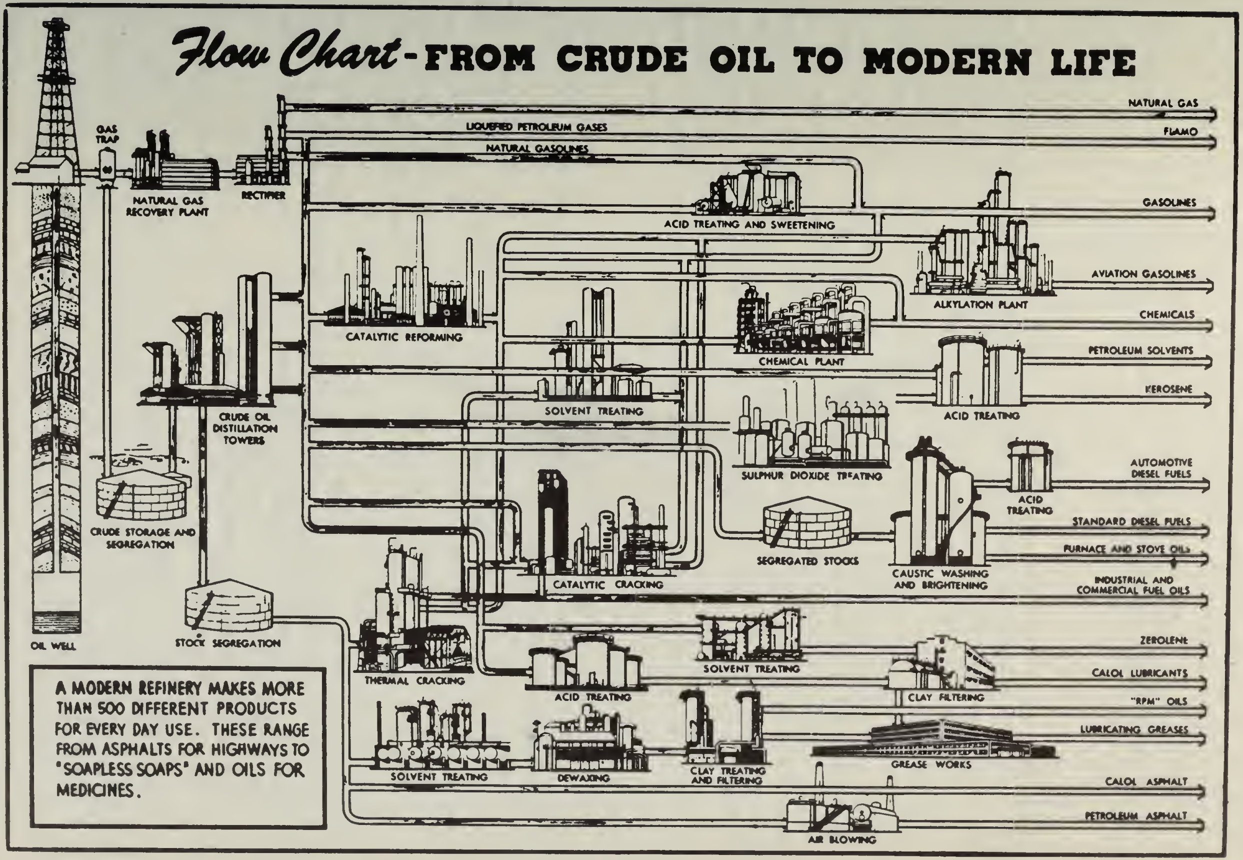
Flow Chart - FROM CRUDE OIL TO MODERN LIFE
OIL WELL
GAS TRAP
NATURAL GAS RECOVERY PLANT
RECTIFIER
CRUDE STORAGE AND SEGREGATION
CRUDE OIL DISTILLATION TOWERS
STOCK SEGREGATION
LIQUEFIED PETROLEUM GASES
NATURAL GASOLINES
CATALYTIC REFORMING
ACID TREATING AND SWEETENING
SOLVENT TREATING
CHEMICAL PLANT
ALKYLATION PLANT
ACID TREATING
SULPHUR DIOXIDE TREATING
ACID TREATING
CATALYTIC CRACKING
SEGREGATED STOCKS
CAUSTIC WASHING AND BRIGHTENING
THERMAL CRACKING
ACID TREATING
SOLVENT TREATING
CLAY FILTERING
SOLVENT TREATING
DEWAXING
CLAY TREATING AND FILTERING
GREASE WORKS
AIR BLOWING
NATURAL GAS
FLAMO
GASOLINES
AVIATION GASOLINES
CHEMICALS
PETROLEUM SOLVENTS
KEROSENE
AUTOMOTIVE DIESEL FUELS
STANDARD DIESEL FUELS
FURNACE AND STOVE OILS
INDUSTRIAL AND COMMERCIAL FUEL OILS
ZEROLENE
CALOL LUBRICANTS
"RPM" OILS
LUBRICATING GREASES
CALOL ASPHALT
PETROLEUM ASPHALT
A MODERN REFINERY MAKES MORE THAN 500 DIFFERENT PRODUCTS FOR EVERY DAY USE. THESE RANGE FROM ASPHALTS FOR HIGHWAYS TO "SOAPLESS SOAPS" AND OILS FOR MEDICINES.

FIGURE 5. *Courtesy of Standard Oil Company of California.*

This refinery is the largest on the Pacific Coast and is spread over 1900 acres. The plant manufactures over 1,000 different products and employs 3,600 people (excluding employees in affiliated research companies at the same location). The capital expenditure for plant and equipment represents an investment of over $15,000 per employee. Crude oil capacity is rated in excess of 100,000 barrels per day.

Shell Oil Company Refinery.[47] Location: Martinez. Ownership: Shell Oil Company, 100 Bush Street, San Francisco.

Preliminary steps toward establishing the refinery were taken in 1914, and the first barrel of crude oil flowed through the completed (Trumble type) plant on January 15, 1916. Its original capacity was about 20,000 barrels of crude oil per day, which was "piped in" from the Coalinga oil fields in western Fresno County. Dubbs thermal cracking units were added at a later period. This was followed by the development of the solvent refining process for manufacturing lubricating oils. Here, certain undesirable constituents in the basic lube stock were dissolved, after which the solvent was removed by distillation. The chemical treatment of lubricating oils with activated clay was developed to remove sludge-forming compounds. About 1936 a new pipeline was constructed from Bakersfield to Martinez to accommodate the company's increased production of crude oil in the San Joaquin Valley. Close cooperation between the refinery and the research laboratories of the company has resulted in the development of many new products and processes. During World War II attention of the research department was turned toward the development of a 100-octane fuel of commercial grade for use in the aviation industry.

Tide Water Associated Oil Company Refinery. Location: Associated (Avon). Ownership: Tide Water Associated Oil Company, 79 New Montgomery Street, San Francisco.

Construction of this refinery began in 1913 by the Associated Oil Company, one of the predecessor companies. In 1926 Associated Oil Company merged with Tide Water Oil Company to form the present organization. The company owns about 2200 acres in the plant area.

The principal sources of crude petroleum processed here are the Ventura Avenue field, Ventura County, and fields in the Bakersfield-Coalinga area in the San Joaquin Valley. The crude from the Ventura Avenue field is transported to the refinery by tanker; the San Joaquin Valley crude is moved through a pipeline system. About 60 percent of the crude comes from the Ventura Avenue field.

Among the 350 different products made here are gasolines, kerosene, fuel oils, automotive lubricants, industrial lubricants, and miscellaneous solvents, oils, and automotive specialties. The plant has a daily capacity of 53,100 barrels for catalytic cracking, viscosity-breaking, and thermal cracking. Total refining capacity is 85,000 barrels of crude per day. About 1500 persons are employed regularly at this plant.

Union Oil Company Refinery. Location: Oleum. Ownership: Union Oil Company of California, 617 West 7th St., Los Angeles.

Union Oil Company purchased the refinery site at Oleum in 1895, and began operations the following year. The plant has been progressively enlarged to its present capacity of 76,000 barrels of crude oil per day. The crude oil is delivered to the plant by tanker from Port San Luis, and by pipeline from fields in the San Joaquin Valley. The Santa Maria field in Santa Barbara County is an important source of the crude oil refined at this plant. A wide variety of petroleum products, numbering almost 500, are manufactured. These include gasoline, stove oil, diesel oil, fuel oil, asphalts, lubricating oils, waxes, and greases. The average monthly payroll at Oleum is approximately $600,000. Recent expansion and modernization of facilities have required an additional investment of $12,500,000.

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[47] Shell Oil Company, Martinez refinery (a booklet).
McPhee, D. G., Shell Company of California: California Oil World.

Pyrite

Stauffer Chemical Company Pyrite Roasting Plant. Location: Stege Siding, Richmond. Ownership: Stauffer Chemical Company, 636 California Street, San Francisco. The pyrite roasting operation is a unit of the Stege plant which produces a wide variety of industrial chemicals.

Pyrite is used here as a source of sulfur for the manufacture of sulfuric acid by the contact process. Pyrite having an average sulfur content of more than 50 percent is obtained from the Shasta County deposits of the Mountain Copper Company. The pyrite, crushed to minus one quarter inch size, is delivered to the plant in gondola cars and unloaded to stock piles where several months supply is maintained. It is elevated from the stock piles to hoppers feeding six Herreshoff furnaces. The furnaces are essentially upright cylinders having six horizontal shelves or hearths over which the pyrite passes in traveling from the top to the bottom of the furnace. Horizontal arms or rabbles attached to a rotating vertical shaft running through the center of the furnace, draw the pyrite toward openings through which it falls from hearth to hearth. The burned material, synthetic hematite (iron oxide), contains less than 2 percent sulfur when discharged at the bottom of the furnace. Air is drawn through the furnaces by a counter-current vacuum blower system. No fuel is required in this operation, the burning pyrite supplying the necessary heat. Normally, the maximum temperature obtained in the furnaces during the burning of the pyrite is 1500° Fahrenheit. In burning, the sulfur in the pyrite is oxidized to sulfur dioxide gas which is conducted through flues to the sulfuric acid plant. Here, after a preliminary scrubbing with dilute sulfuric acid, the sulfur dioxide is oxidized to sulfur trioxide through the use of a vanadium oxide catalyst. The sulfur trioxide is then dissolved in a mixture of strong sulfuric acid and water. About 2000 tons of pyrite is burned monthly in this plant to produce about 2500 tons of 99 percent sulfuric acid. Capacity of the plant will be substantially increased by the installation of an additional large Herreshoff furnace.

General Chemical Division Plant. Location: Nichols. Ownership: General Chemical Division, Allied Chemical and Dye Corporation, 235 Montgomery Street, San Francisco. A pyrite roasting plant similar to the Stauffer plant, described above, is an important unit of this plant which produces heavy and fine chemicals and agricultural chemicals.

Refractories

Gladding, McBean & Company (Stockton Firebrick Company). Location: Southern Pacific Road, Pittsburg. Ownership: Gladding, McBean & Company, 9th and Harrison Streets, San Francisco.

The plant was established by a predecessor company in 1931 and acquired by the present operator in 1934. Numerous grades of fire clay, mined at Lincoln, Placer County, and Ione, Amador County, are shipped in by railroad and stock piled in the yard. These clays are calcined in a counter-current gas-fired rotary kiln 7 feet in diameter and 100 feet long, where the original water content of about 15 percent is eliminated. After calcining, clays are stored in yard storage bins. The desired quantity of each clay is withdrawn by chute to a batch-loading car operated in an underground tunnel. These batches are sent to the dry-grinding pans on conveyor belts. After grinding, the crude clay is conveyed to the screens, which range in size from 6- to 14-mesh. The screened clay is conveyed to a series of 18 overhead storage tanks, each holding 100 tons. Screened clay can be withdrawn to a second batch car and delivered to a Simpson mixer for further conditioning.

Three processes are employed in working the clay. The stiff-mud process is employed for ladle products; whereas the dry-pressed process is employed for boiler and furnace linings, and similar products. Special shapes are hand-molded. In the stiff-mud process, the clay is withdrawn from the mixing machine and passed to a pug mill, where it is de-aired and extruded through a die. The extruded ribbon is wire-cut, repressed, and sent to the stiff-mud drying kiln. The shapes require about 2 days to pass through this kiln, where the moisture is reduced to approximately half of 1 percent. After drying, they are sent to the tunnel-kiln dryer, and then to the tunnel kiln. Shapes are made by the dry press in the following manner: movable trays fill the molds with clay that undergoes two periods of compression, first from the top and second from the bottom. The pressed brick is elevated to the tray level, removed, passed through the tunnel kiln dryer, and then fired in the kiln. The Harrop kiln designed to burn products up to cone 17, is about 400 feet in length. It is operated at the rate of 32 cars per 24-hour day, each car remaining in the kiln 2 days.

This plant is equipped to make about 1500 different shapes. Two brand names are used on most of these products. High temperature products are sold under the name ''Diablo'', and are capable of withstanding a temperature of about 3400° Fahrenheit. The lower temperature products are sold under the name ''Carnegie'', and can withstand a temperature of about 2600° Fahrenheit. Permanent employment is provided at this plant for 95 to 120 people. Most of the personnel work on the day shift, although the firing department works on a three-shift day. The rated capacity of the plant is about 5000 tons of burned products per month.

TABULATED LIST OF CONTRA COSTA COUNTY MINERAL DEPOSITS

The list of mineral deposits is arranged alphabetically by the name of the deposit. The mineral commodity produced is indicated in the column headed ''Remarks''. A separate list of natural gas wells is given in table 10, and a list of wildcat wells (dry holes) will be found in table 11. The term ''proj.'' (for projected) indicates that the area has not been included in the public land survey. The number following the colon in bibliographic abbreviations listed under ''Remarks'' is the page number. If only the author's name and date are given, the complete reference will be found in the accompanying bibliography.

CONTRA COSTA COUNTY MINERAL DEPOSITS

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS**
			SEC.	T.	R.	B & M	
7	Alhambra Springs	E.R. and L.W. Lasell, 700 Castro St., Martinez.	*/ 7	1N	2W	MD	Mineral water. (R23:16-17; Waring, USGS WSP 338:293-294; herein).
10	Alvernez	M. Alvernez, Rt. 1, Box 589, Pittsburg. Leased to Pittsburg Pumice Industries, Rt. 1, Box 21, Pittsburg.	15	2N	1W	MD	Pumice. (B149:96). Pumice in Lawler tuff. Small quantity used in lightweight building blocks.
	Antioch-Marchio						See Marchio Sand Co.
12	Antioch Sand Co.	Antioch Sand Co., 1806 - 30th Ave., San Francisco. Leased to Macal Construction Co., Antioch.	SW¼17	2N	2E	MD	Sand. (R17:61; R23:29-31; herein). Has produced aggregate sand from dune area for many years.
11	Bailey Ranch	A.S. Bailey, Bailey Rd., Pittsburg. Leased to Diablo Pumibloc Co., Rt. 1, Box 163, Pittsburg.	23	2N	1W	MD	Pumice. (B149:95; herein). Fragmentary pumice, Pliocene age, used in lightweight building blocks.
	Ball Sons, N.M.						See Unnamed map no. 39.
13	Basalt Rock Co.	Basalt Rock Co., 8th St., Napa, lessee.	SE¼18	2N	2E	MD	Sand. (Herein). Aggregate sand, intermittent production.

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
43	Black Diamond (Nortonville; Pittsburg-Roberts; Roberts Sand Co., Columbia Steel Co.)	Southport Land & Commercial Co., 220 Montgomery St., San Francisco. Leased to Roberts Sand Co., Box 323, Pittsburg.	4,5,8, 9	1N	1E	MD	Coal, clay, sand. Mined for sand 1925-1948. (R4:267; R7:118-153; R17:53-55; R23:13-14; R44:42; USBM Tech. Paper 696:4-5, 61-52; Goodyear, 1877; herein).
27	Blake Brothers (San Pablo)	Blake Brothers, Box 1002, Richmond.	15,16	1N	5W	MD	Stone. (R17:63-64; R23:21-23; herein). Franciscan sandstone; operation began in 1907; open pit, shovels and crushing plant.
	Brentwood Mines						See Hoisting Shaft.
28	Brooks Island	Healy-Tibbetts Construction Co., 411 Brannan St., San Francisco.	*/25	1N	5W	MD	Stone. Idle. (R23:23).
8	Byron Hot Springs	Greek Archdioces of North and South America, Byron.	15	1S	3E	MD	Mineral water. (R8:163; R11:193; R17:56-60; R23:17-18; USGS WSP338:109-112, 293).
74	California Peat Co.	California Peat Co., Box K, Antioch.	1,2 11,12	2N	3E	MD	(Herein). Peat for agriculture.
44	Central (Stewart's)	L.Ginochio, Rt. 1., Box 6, Antioch.	10	1N	1E	MD	Coal. Idle. (R4:267; R7:118-153; R9:165; R 10:85; R12:48-50; R13:52).
29	Christen	P.L. Davison, Rt. 1, Box 297, Martinez.	*/34 (?)	2N	2W	MD	Stone. Idle. (R23:25).

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
1	Clark & Sons N.	C.J. Garibotti, Rt. 1, Box 488, Walnut Creek.	*/26	1N	2W	MD	Clay. Idle. (R17:49; R23:13; PR7:44-46).
	Columbia Steel Co.						See Longwell Ranch (Central pit), and Black Diamond.
14	Cowell	Henry Cowell Lime & Cement Co., 2 Market St., San Francisco.	*/8	1N	1W	MD	Sand. (Herein.) Fill material.
4	Cowell, Henry, Lime & Cement Co.	Henry Cowell Lime & Cement Co., 2 Market St., San Francisco.	*/8,9 16,17	1N	1 W	MD	Limestone, cement. Idle: limestone deposits worked out. (R17:51-53, 55; R23:9-12; R43: 221-222; herein).
	Dohrman						See Pinole.
	Eagle Peak		26	1N	1W	MD	Copper. Idle. Location uncertain. (R23:15; B50:171; B144:224; herein).
30	El Cerrito (Stege)	Subdivided.	*/22	1N	4W	MD	Stone. Idle. (R23:23-25; B38:317). Operated to 1944; permit revoked by City of El Cerrito.
45	Empire	L. Ginochio, Rt. 1, Box 6, Antioch.	SW$\frac{1}{4}$12	1N	1E	MD	Coal. Idle. (R4:267; R7:142-144; R8:160; R9:165; R10:165; R11:191-192; R12:44; R13: 51).
	Engine Shaft	Isabel Pomba, Rt. 1, Box 251-D, Brentwood.	S$\frac{1}{2}$22	1N	2E	MD	Coal. Idle. Location uncertain. (R7:145; R18 152-157)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
31	Harrison-Birdwell	G. Murchio, Brentwood. Leased to Harrison-Birdwell, Clayton.	14,23	1N	1W	MD	Stone. (Herein). Franciscan sandstone. Open pit shovel operation and crushing plant.
	Hazel-Atlas Glass Co.						See Pittsburg Sand Co.
	Hoisting Shaft (Brentwood Mines)	Isabel Pomba, Rt. 1, Box 251-D, Brentwood.	SE¼22	1N	2E	MD	Coal, clay. Idle. Location undertain. (R7: 145).
	Israel Opening	R. Gursky, Rt. 1, Box 41-C, Brentwood.	18	1N	2E	MD	Coal. Idle. Location uncertain. (R7:144).
32	Kaiser, Henry J.	Henry J. Kaiser Co. 1924 Broadway, Oakland.	3,4 9,10	1S	3W	MD	Stone. (Herein). Basalt and rocks of Moraga formation; power shovels.
15	Kaiser, Henry J.	Southern Pacific Co. 65 Market St., San Francisco. Leased to Henry J. Kaiser Co., 1924 Broadway, Oakland.	NE¼28	2N	2E	MD	Sand. (Herein) Aggregate sand. Idle in March 1951.
16	Longwell Ranch - Central pit (Columbia Steel Co.)	S.L. Longwell, Box 292, Brentwood. Leased to Owens-Illinois Glass Co., 601-36 Ave., Oakland.	6	1S	3E	MD	Sand. Idle. Small quantity of foundry sand produced prior to 1925.

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
17	Longwell Ranch - North pit (Silica Co. of California)	S.L. Longwell, Box 292, Brentwood. Leased to Owens-Illinois Glass Co., 601-36 Ave., Oakland.	6	1S	3E	MD	Sand. Idle. Large quantity of glass sand and some foundry sand were produced by underground methods; now caved.
18	Longwell Ranch - South pit (Silica Co. of California)	S.L. Longwell, Box 292, Brentwood. Leased to Owens - Illinois Glass Co., 601-36 Ave., Oakland.	SW¼6	1S	3E	MD	Sand. Idle. Large quantity of glass sand and some foundry sand produced by surface methods using earth-moving equipment.
	Los Angeles Pressed Brick Co.						See United Materials and Richmond Pressed Brick Co., Ltd.
19	Marchio Sand Co. (Antioch-Marchio)	L. Ginochio, Rt. 1, Box 6, Antioch. Leased to Marchio Sand Co., Antioch.	NW¼11	1N	1E	MD	Sand. Small pit operated during wet weather. Sand used in steel foundry.
20	Marchio Sand Co. (Antioch-Marchio)	L. Ginochio, Rt. 1, Box 6, Antioch. Leased to Marchio Sand Co., Antioch.	SW¼12	1N	1E	MD	Sand. At Star Mine. (R44:40-41; herein). Foundry sand.
21	Morris	George Stamm, 5th and B Sts., Antioch Leased to Ben Morris and W.G. McCullough, Rt. 1, Box 100, Antioch.	SE¼18	2N	2E	MD	Sand. (R23:31; herein). Substantial producer of aggregate sand from dune area. Worked with bulldozer and conveyor-loader.

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
6	Mount Diablo (Ryne)	Mount Diablo Quicksilver Mining Co., c/o Bradley Mining Co., Crocker Bldg., San Francisco.	SE$\frac{1}{4}$29	1N	1E	MD	Mercury. (R8:162; R23:21; R35:374-375; B27:195; B78:41; USGS B922-B:31-54; USGS M13:378-379). Open pit and underground.
	Mount Zion Chrome			1N	1W	MD	Chromite. Idle. Location uncertain. (R23:12; herein).
	Mount Zion Copper		27	1N	1W	MD	Copper. Idle. Location undertain. (R23:15; B50:171; B144:224; herein).
	Nortonville						See Black Diamond.
9	Oak Springs	Coy Filmer, 330 Jackson St., San Francisco. Leased to Fox Water Co., 675 - 37th St., Oakland.	3	1S	3W	MD	Mineral water. (Herein).
33	Old Stege (Stege)	Berkeley Council, Boy Scouts of America, 2068 Allston, Berkeley.	*/15	1N	4W	MD	Stone. (R17:61; R24:23). Quarry now used as camp grounds.
	Pawsey						See Pinole.
	Peacock		7	1N	1E	MD	Coal. Idle. Location undertain. (R4:267; R7:140).
	Pinole (Dohrman; Pawsey)	Several owners.	20,21	2N	4W	MD	Diatomite. Idle. Crops out over considerable area in and west of Pinole. (23:15; herein).

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
46	Pittsburg (Somersville)	Southern Pacific Co., 65 Market St., San Francisco, and L. Ginochio, Rt. 1, Box 6, Antioch (?)	SE$\frac{1}{4}$4	1N	1E	MD	Coal, sand. Idle. (R4:267; R7:118-153; R8:160-161; R10:165; R11:192; R12:44-46; R13:51-52; R17:53-55; R23:13-14). Glass sand 1932-1946.
	Pittsburg-Roberts						See Roberts Sand Co.
22	Pittsburg Sand Co. (Hazel Atlas Glass Co., Pittsburg; Somersville).	Southern Pacific Co., 65 Market St., San Francisco, and L. Ginochio, Rt. 1, Box 6, Antioch (?)	SE$\frac{1}{4}$4	1N	1E	MD	Sand. Idle. (R44:42; herein). Large quantity of glass sand produced by room and pillar method, 1932-1946.
	Point Isabel	Berkeley Waterfront Co., c/o Santa Fe Railway Co., 121 East 6th St., Los Angeles.	29	1N	4W	MD	Stone.
	Point Molate	North Bay Realty Co., Box 1126, Richmond. Leased to U.S. Navy.	9	1N	5W	MD	Stone. Idle. (R17:62-63). Pit now used as oil storage sump.
	Point Richmond						See Richmond.
2	Port Costa Brick Works	Port Costa Brick Works, 401 Berry St., San Francisco.	*/10	2N	3W	MD	Clay. (R17:50; R23:8; B99:73-74, 326).

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
5	Red Rock	Riehl, Rogers & Rogers, 527 Commercial St., San Francisco.	*/17	1N	5W	MD	Manganese. Idle. On Red Rock Island. (B152: 50; R17:55-56; herein).
	Richmond (Point Richmond)	Richfield Oil Co., Richfield Bldg., Los Angeles.	23	1N	5W	MD	Stone. Idle. (R23:27).
	Richmond Pressed Brick Co.						See United Materials and Richmond Pressed Brick Co., Ltd.
23	Roberts Sand Co. (Black Diamond; Pittsburg-Roberts)	Southport Land & Commercial Co., 220 Montgomery St., San Francisco. Leased to Roberts Sand Co., Box 323, Pittsburg.	SE$\frac{1}{4}$5	1N	1E	MD	Sand. Idle. (R44:42; herein). Large quantity of foundry sand produced from Eocene beds by room and pillar method.
	Ryne						See Mount Diablo.
	San Francisco		7	1N	1E	MD	Coal. Idle. Location uncertain. (R4:267; R7:140).
	San Pablo						See Blake Brothers.
37	Serra Brothers (Slater)	C.C. Slater, Rt. 1, Box 369, Martinez. Leased to Serra Brothers, Rt. 1, Box 335, Martinez	*/34	2N	2W	MD	Stone. (R17:65; B38:317; herein). Sandstone for roads and fill material.

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Silica Co. of California						See Longwell Ranch (North and South pits, and Stone House Ranch.
	Slater						See Serra Brothers.
	Somersville						See Pittsburg.
47	Star	L. Ginochio, Rt. 1, Box 6, Antioch.	SW$\frac{1}{4}$12	1N	1E	MD	Coal. Idle. (R12:46-48).
	Stege						See El Cerrito, and see Old Stege.
	Stewart's						See Central.
24	Stone House Ranch (Silica Co. of California)	Henry Cowell Lime & Cement Co., 2 Market St., San Francisco.	36	1N	2E	MD	Sand. Idle. (R27:436-437, 1931). Underground; caved.
	Teutonia	B. Gursky, Rt. 1, Box 41-C, Brentwood.	SW$\frac{1}{4}$7	1N	2E	MD	Coal. Idle. Location uncertain. (R7:144-145).
3	United Materials and Richmond Pressed Brick Co., Ltd. (Los Angeles Pressed Brick Co., Richmond Pressed Brick Co.)	United Materials and Richmond Pressed Brick Co., Ltd., Box 7, Point Richmond.	23	1N	5W	MD	Clay. (R17:51; R23:8-9; B99:74-75; herein).
	Unnamed		SW$\frac{1}{4}$16	1N	2E	MD	Coal. Idle. Location uncertain. (R7:144-145).

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
25	Unnamed	M. Grunauer, 308 South Bedford Ave., Beverly Hills.	7	1S	3E	MD	Sand. Idle. Small hillside quarry in sandstone, $1\frac{1}{2}$ miles southeast of Longwell Ranch.
38	Unnamed	J. Mendonca, Rt. 1, Box 588, Pittsburg.	NE$\frac{1}{4}$16	2N	1W	MD	Stone. Idle. Friable Neroly sandstone.
41	Unnamed	Ginochio Brothers, Rt. 1, Box 6, Antioch.	12	2N	2W	MD	Stone. Idle. Fill material. Pliocene beds of clay, shale, conglomerate.
42	Unnamed	Ginochio Brothers, Rt. 1, Box 6, Antioch.	7	2N	1W	MD	Stone. Idle. Fill material. Pliocene beds of clay, shale, and conglomerate.
39	Unnamed	F.A. Marshall, Danville. Leased to N.M. Ball Sons, 3rd and Delaware, Berkeley.	*/25	1N	2W	MD	Stone. Idle. (Herein, described under N.M. Ball Sons.). Sandstone and conglomerate, sea shells; used as fill material.
40	Unnamed	Richfield Oil Co., Richfield Bldg., Los Angeles.	23	1N	5W	MD	Stone. Idle. Franciscan sandstone.
26	Wills	J. Little, Rt. 1, Box 101, Antioch. Leased to F. Wills, Antioch.	SW$\frac{1}{4}$17	2N	2E	MD	Sand. (Herein). Dune area.

*/Projected location.

**/The following abbreviations are used in this column: B-Bulletin, California Division of Mines; PR-Preliminary Report, California Division of Mines; R-Report of the State Mineralogist, California Division of Mines, USBM-United States Bureau of Mines; USGS B-United States Geological Survey Bulletin; USGS M-United States Geological Survey Monograph; USGS WSP-United States Geological Survey, Water-Supply Paper.

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FLUORSPAR IN CALIFORNIA

By James W. Crosby III * and Samuel R. Hoffman *

OUTLINE OF REPORT

Page
Abstract ---- 619
Introduction ---- 619
Mines and prospects ---- 625
  Clark Mountain deposits ---- 625
    Geology ---- 626
    Mineralogy and description of the ores ---- 629
  Other deposits ---- 631

Illustrations

Figure 1. Index map of part of southern California showing location of the Clark Mountain area, San Bernardino County, California 620
2. Areal geologic map of Clark Mountain fluorspar area ---- 626
3. Geologic sketch map of Douglass No. 1 fluorspar prospect, Clark Mountain, San Bernardino County, California ---- 628
4. Geologic sketch map of Douglass No. 2 fluorspar prospect, Clark Mountain, San Bernardino County, California ---- 630
Plate 43. *A*, Photomicrograph of ore from area northwest of Korfist shaft. *B*, Photomicrograph of ore from area northwest of Korfist shaft. *C*. Photomicrograph of ore from Korfist's main incline. *D*, Photomicrograph of ore from the Douglass No. 1 property 632–633
44. Photo of vein fluorspar from the Big Horn No. 9 claim ---- 632–633
45. Photo of fluorspar in andesite breccia ---- 632–633
46. Photo of fluorspar from the White Mountains deposit, Inyo County 632–633
47. Geologic map of a part of Clark Mountain showing occurrences of fluorspar ---- In pocket

ABSTRACT

Fluorspar (fluorite) is a nonmetallic industrial mineral of importance as a flux in the open-hearth process of manufacturing steel, in making hydrofluoric acid, and in the ceramic industry. A relatively new use of hydrofluoric acid is in the alkylation process for the manufacture of 100-octane gasoline. The small amount of fluorspar intermittently produced in California has fallen far short of meeting the increasing demand.

In the present study 19 deposits were investigated and 13 are described as having some possibility of development; none were producing in early 1951. Deposits in which some development work has been done include Warm Spring Canyon, Fluorspar Group, Red Bluff, Afton Canyon, Green Hornet, Primer, Providence Mountain, and Clark Mountain.

Geologic study and mapping of the Clark Mountain deposit, which was being developed in late 1950, shows that fluorspar occurs with sericite in replacement veins of variable thickness along discontinuous shear zones in dolomite. The friable fluorspar-sericite ore at this locality has some commercial possibility, particularly if the sericite proves to be a satisfactory substitute for ground mica.

INTRODUCTION

Pure fluorspar (fluorite) is calcium fluoride (CaF_2) which consists of 51.1 percent calcium and 48.9 percent fluorine. Rarely, however, does a body of fluorspar analyze more than 99 percent CaF_2. Because most commercial fluorspar deposits contain varying amounts of impurities such as silica, calcite, alumina, and oxides of iron, and are commonly associated with barite, galena and sphalerite, the ore from the deposits must be concentrated before shipping.

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Mineralogy. Fluorite crystallizes in the isometric system, usually in the form of cubes, but some fluorite crystals are octahedrons or dodecahedrons. Perfect octahedral (111) cleavage is characteristic of crystalline varieties. The mineral is number four on Mohs scale of hardness and has a specific gravity of 3.01 to 3.25. Compact varieties of fluorspar have a splintery fracture. The mineral displays a wide range of colors, even within a single crystal. The most common colors displayed are purple, white, green, and blue; but yellow, rose-red, crimson-red, violet-blue, sky-blue, brown, wine-yellow, and greenish-blue varieties are occasionally found. Red fluorite is rare. The cause of the color in fluorite has not been determined, but it is known that the color may be modified by various means, such as heat, X-rays, gamma rays, ultra-violet light, and pressure. The color of fluorspar ordinarily is not an indication of its purity, but in certain places color is used as a guide in hand sorting ore from a picking belt. Some specimens exhibit a blue fluorescence in ultra-violet light.

The name fluorite is the one commonly found in works on mineralogy and apparently is more or less confined by common usage to the nearly pure mineral. Fluorspar, on the other hand, is the term used almost

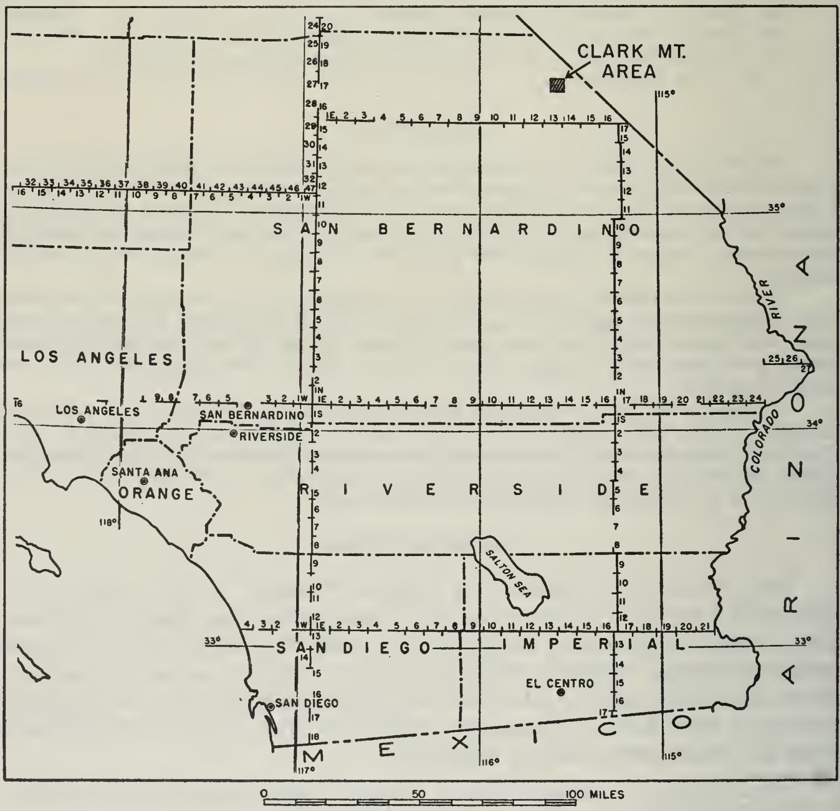
CLARK MT. AREA
115°
35°
SAN BERNARDINO
LOS ANGELES
LOS ANGELES
SAN BERNARDINO
RIVERSIDE
SANTA ANA
ORANGE
118°
34°
RIVERSIDE
SALTON SEA
COLORADO RIVER
ARIZONA
33°
SAN DIEGO
IMPERIAL
33°
EL CENTRO
SAN DIEGO
MEXICO
117°
116°
115°
0
50
100 MILES

FIGURE 1. Index map of part of southern California showing location of the Clark Mountain area, San Bernardino County, California.

exclusively in commercial practice. Early references to the mineral in the literature designated it ''fluate of lime.'' Common practice of miners in many districts is to call fluorite ''spar.'' However, because this term may also apply to barite (heavy spar), feldspar, calcite (calc-spar), gypsum, and even quartz, the term ''spar'' in reference to fluorspar is to be avoided.

Occurrence. Fluorspar is one of two commercially important fluorine-bearing minerals; the other is cryolite, a sodium aluminum fluoride (Na_3AlF_6), which contains 54.4 percent fluorine. The deposit of cryolite at Ivigtut, Greenland, is the only one in the world where the mineral is produced on a commercial basis.

Almost without exception, commercial fluorspar deposits are associated with faults or fault zones. The fluorspar may be present as a simple filling of the fault zone, as a replacement of sedimentary strata near faults, as a filling of any solution cavities near faults, or as a residual deposit resulting from the weathering of one of the first three types. Of the above mentioned types, the replacement of sedimentary strata accounts for the majority of all large deposits. This is particularly true of fluorspar deposits developed in sedimentary beds rich in calcite, such as limestone, calcareous shale, and calcareous sandstone. That calcareous strata are especially susceptible to replacement by fluorspar is shown in the Illinois-Kentucky fluorspar district, where a series of sedimentary beds consisting of shales, sandstones, and limestones are broken in a number of places by faults mineralized with fluorspar. Where the fissures cut limestone or calcareous beds, the veins generally are wide because of the replacement that has taken place. However, where the fissures cut beds of sandstone or shale, many of the veins are narrow or pinch out entirely.

Uses.[1] Fluorspar has a wide variety of uses and is assuming new ones every year. The largest consumption of fluorspar is by the steel industry in which the mineral is necessary for the production of steel by the basic open-hearth process. The second most important use is in manufacturing hydrofluoric acid, and the third is its use by the ceramic industry. These three industries annually consume about 90 percent of all fluorspar produced. Additional quantities are consumed in making enamel, iron, ferro-alloys, primary aluminum and magnesium, cement, welding-rod coatings, and chemicals. One of the more important chemicals is uranium hexafluoride, used for the gaseous diffusion separation of the uranium isotopes U_{235} and U_{238} in the development of atomic energy. Miscellaneous uses not listed above require small percentages of the mineral. It is to be expected that the number of uses for fluorspar will increase rapidly within the next few years and that the quantity consumed by the manufacture of hydrofluoric acid will become much greater because of the many new processes being developed which require the use of the acid.

The use of fluorspar in the production of steel or in other metallurgical processes depends upon its low melting point (1270° to 1387° C), upon its low viscosity when molten, and upon its ability to form eutectics so as to flux silica, calcium and barium sulfates, alumina, and other materials which are highly refractory. The formation of these eutectics results in an easily fusible and very fluid slag, which of course, is desirable. Fluorspar also tends to volatilize or to form a slag with phosphorus, sulfur, and other unwanted impurities in iron and other metals.

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[1] Ladoo, R. B., Fluorspar; its mining, milling, and utilization with a chapter on cryolite: U. S. Bur. Mines Bull. 244, 1927.

The amount of fluorspar used in each heat of the basic open-hearth furnace depends entirely upon the type of ore and contained impurities making up the charge. If the percentage of silica, alumina, and sulfur contained in the ore is high, a large amount of fluorspar is necessary to lower the melting point sufficiently to give fluidity to the slag. The average quantity of fluorspar consumed per long ton of basic open-hearth steel produced was 5.86 pounds in 1948, 5.54 pounds in 1947, and 5.39 pounds in 1946. In 1949 the figure decreased slightly from the 1948 level and was 5.85 pounds per tons. The general trend upward in the quantity of fluorspar used per ton of steel during the past few years may be indicative of a lower grade of ore being used by the steel foundries. With the depletion of the higher-grade Lake Superior iron ores this figure may continue its upward trend.

Large quantities of fluorspar are consumed annually in the production of hydrofluoric acid (HF). In this process the finely ground mineral (80 to 100 mesh) is treated with sulfuric acid producing a reaction which is essentially:

$$\underset{\text{(fluorite)}}{CaF_2} + \underset{\text{(sulfuric acid)}}{H_2SO_4} = \underset{\text{(hydrofluoric acid)}}{2HF} + \underset{\text{(calcium sulfate)}}{CaSO_4}$$

This reaction will take place at ordinary temperatures, but complete dissociation takes place only at temperatures above 130° C. The operation is carried on in platinum or cast-iron retorts and the hydrofluoric acid produced is distilled and collected in lead-lined containers filled with water.

Hydrofluoric acid is used for etching glass and in manufacturing fluorine chemicals, hydrofluosilicic acid (H_2SiFO_6), which is used in making fluosilicates such as magnesium silicofluoride ($MgSiF_6$), an ingredient of concrete hardeners. Additional uses of hydrofluoric and hydrofluosilicic acid are in making sodium fluoride (NaF), which is used in ceramics, as a food preservative, as an antiseptic, as an antifermentative in alcohol distilleries, and as a wood preservative; sodium silicofluoride (Na_2SiF_6), which is used in ceramics and in medicine, and is a substitute for oxalic acid for certain bleaching purposes; calcium silicofluoride ($CaSiF_6$), used principally in ceramics; barium fluoride (BaF_2), used in enamels, in embalming fluids, and as an antiseptic; and potassium fluoride (KF), used in etching glass and as a wood preservative. A newly developed use for hydrofluoric acid is in the production of synthetic organic compounds of fluorine and chlorine sold under the trade name of "Freon." These gases are used as refrigerants in household and commercial refrigerating systems, in air-conditioning units, and as solvents and propellants for insecticides. Another new use for hydrofluoric acid is the alkylation process for manufacturing 100-octane gasoline. This process opens up a very large field which is dependent upon a large and steady production of fluorspar. Because fluorine will substitute freely with many of the elements in organic compounds, many new and startling developments may be expected in the next few years; although substitutes may be found for fluorspar in some of its present uses, the outlook for the future is exceedingly bright and the annual consumption may be expected to increase considerably.

The glass industry, which annually consumes the third greatest amount of fluorspar, requires it in manufacturing opal or opaque white glass and colored or cathedral glass. Light opal glass is used for vases, bowls, and other ornamental glassware. A denser variety of opal glass is used for making so-called ointment pots, such as cosmetic and food jars and bottles. The dense opal glass is also used for electric light shades and globes and architectural panels and slabs. Cathedral glass, as its name would suggest, is commonly used for church windows and other decorative panels. Small quantities of fluorspar are consumed in the production of enamels; the mineral serves as a flux and as a secondary opacifying agent. The value of fluorspar in the manufacturing of glass products depends upon the crystallization of fluorides in the glass, giving a milky or opalescent effect.

Mining Methods.[2] Because the geological occurrence of fluorspar is little different from the occurrence of any of the metallic ores, the methods of mining are essentially the same. The operating mines in the United States may be divided into three main types depending on the mining methods employed. These are: (1) open-cut mining, (2) drift and tunnel mining, and (3) shaft mining. Of the three, the last, or mines opened by shafts, is by far the most important.

Mining fluorspar in open cuts is feasible only where the ore consists of residual gravel and lump fluorspar in a matrix of loose sand and clay. Deposits of this nature must be of wide areal extent because operations usually cannot be carried on successfully at depths much greater than 30 feet. Such mining practice must be carried out with extreme care, as it may become necessary later to sink a shaft, and careless open-cut mining could easily make future shaft sinking impossible, or possible only at great expense.

Bedded fluorspar deposits which lie at a greater elevation than the surrounding country can be exploited advantageously by drifting. This type of mining has many advantages, the principal ones being that no hoisting is required, and often no pumping is necessary. Fluorspar veins that dip at a steep angle and are in a region of rugged topography are also amenable to mining by drifts. Bedded fluorspar deposits are generally mined by a modified room-and-pillar system, such as is sometimes used in coal mining.

Deposits which are opened by shafts constitute the majority of the mines in the United States. The mines differ greatly in size, production, working methods, efficiency of operation, and in other ways. Once the shaft is sunk, drifts are driven and the ore is removed by one of the common methods of stoping.

Milling.[3] The methods employed in the concentration or milling of fluorspar depend on the nature and quantity of the impurities present in the ore and on the type of ore being treated. The impurities which may be present in any given ore may be classified as either diluents or harmful impurities. Diluents constitute minerals present in the ore which have no harmful effects in the process for which the flurospar is to be utilized; harmful impurities have an injurious effect in the process for which the fluorspar is to be used and should be removed entirely or reduced to a very low percentage.

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[2] Ladoo, R. B., op. cit.
[3] Ladoo, R. B., op. cit.

The common diluents are calcite or any form of calcium carbonate, silica in any form, silicates and alumina-silicates (particularly feldspars), granite, slate, shale, sandstone, sand, clay, and other types of wall rock. Although these materials do not have harmful effects in the uses to which the fluorspar is put, they nevertheless require fluxing. Therefore, penalties are imposed for their presence in the fluorspar concentrate. The penalty for the common impurity, silica, is calculated on the following basis: percentage fluorspar minus 2.5 times the percentage silica = the effective fluorspar content. For example, a concentrate containing 97 percent fluorspar and 3 percent silica would have an effective fluorspar content of 89.5 percent ($97\% - 2.5 \times 3\% = 89.5\%$). All fluorspar is purchased on the basis of effective fluorspar content.

The harmful impurities are generally considered to be barite, galena, sphalerite, pyrite, all other sulfides and sulfates, all other lead and zinc minerals, and all iron compounds (iron produces an undesirable color in glass and enamel).

The methods used in concentrating fluorspar ores are dependent upon the type and physical characteristics of the impurities. The ores may be classified in three broad groups which cover the great majority of deposits. The groups are arbitrary and are based on the type of gangue associated with the fluorspar. They are: (1) residual and/or disintegrated ores in which the adulterants are chifly sand and clay; (2) massive crystalline ores in which the gangue may be separated easily from the fluorspar; and (3) mixed ores in which the fluorspar is intimately associated with other vein materials or with the country rock.

Ores belonging to the first group are concentrated without much difficulty by washing away the admixed sand and clay. A low grade ore of this type may generally be concentrated to a high-grade product at a minimum cost. The ores in the second group are more difficult to concentrate, but a high-grade product may sometimes be obtained by hand-sorting. If additional or different treatment is required, good results are obtained by jigging. By this process, ores containing as little as 50 percent fluorspar may be concentrated into a product of good grade without employing flotation if the principal gangue mineral is calcite. If the principal gangue mineral is quartz, however, a higher percentage of fluorspar is required to meet specifications.

Ores in the third group are usually difficult to concentrate. They consist of intimate mixtures of fluorspar and silica, silicates, galena, barite, sphalerite, and other minerals, and require flotation to accomplish a satisfactory separation. The concentration of these ores has been economically feasible for only a few years, but an ore containing high percentages of galena, sphalerite, and fluorite may now be treated so that the concentrates of each of the three minerals will meet the minimum requirements of most buyers. The use of flotation methods to concentrate fluorspar ores may allow the profitable mining of deposits which were previously considered to be too low grade. To illustrate, ores containing as little as 50 percent fluorspar and as much as 50 percent silica may now be concentrated to produce fluorspar of acid grade (97% effective CaF_2). The discovery of better flotation reagents will undoubtedly result in the ability to handle ores with smaller percentages of fluorspar and higher percentages of impurities.

The improvements which have been made in the treatment of fluorspar ores are indeed comforting to producers in California; although the state has several deposits which show promise, all of them are relatively low-grade ores containing high percentages of silica. The inability to concentrate these ores economically has hindered possible development of the fluorspar industry in the state.

MINES AND PROSPECTS

Clark Mountain Deposits

The Clark Mountain fluorspar area is on the north side of Clark Mountain, about 35 miles northeast of the town of Baker, San Bernardino County, California. The Ivanpah quadrangle, scale 1/250,000, is the only topographic map available for the area at the present time.

The Clark Mountain fluorspar area is easily accessible by unimproved roads which join U. S. Highway 466 near Valley Wells Station. Except for light winter snows and occasional heavy rains, which, at times, leave the roads in poor condition for a few hours or days, the area is accessible throughout the year.

Clark Mountain, one of the highest peaks in the Ivanpah quadrangle, has an elevation of 7,903 feet. The fluorspar-bearing area, however, is at a lower elevation on the north side of the mountain. The vegetation in the area is sparse and characteristic of arid regions; there are numerous small stands of scrub pine and a few willows. Rains and snow are common during the winter months, but few are of long duration. Cloudbursts are especially common to the area during the summer months, and it is likely that much of the present topography has been carved by these torrential rains.

The only streams in the area are intermittent, resulting from melting snows or heavy rains, and none flows for more than a few days at a time. Several small springs in the top parts of the mountain flow continually but quickly pass into the valley wash.

Persons living in the area are dependent upon a well at the site of the old Colluseum mine camp for their water supply, and according to their report all of their needs have been supplied without lowering the water level. Some of the residents believe the well could supply sufficient water to operate a small mill.

Dr. D. F. Hewett of the United States Geological Survey kindly outlined the regional geology for the writers before the field work was begun. Dr. Adolph Pabst of the University of California generously donated his time to the preparation of X-ray diffraction patterns. Discussions with him regarding the mineralogy of the ores were very helpful. To the owners of the fluorspar claims in the Clark Mountain area who were extremely helpful and cooperative, the authors express their gratitude.

Five weeks were spent in the field studying the areal geology and fluorspar deposits. Two weeks in March 1950 were spent studying the areal geology and preparing a plane table map of part of the area. An additional 3 weeks were spent in the field in May and June 1950, during which time the mineralized area was studied in detail. Considerable time

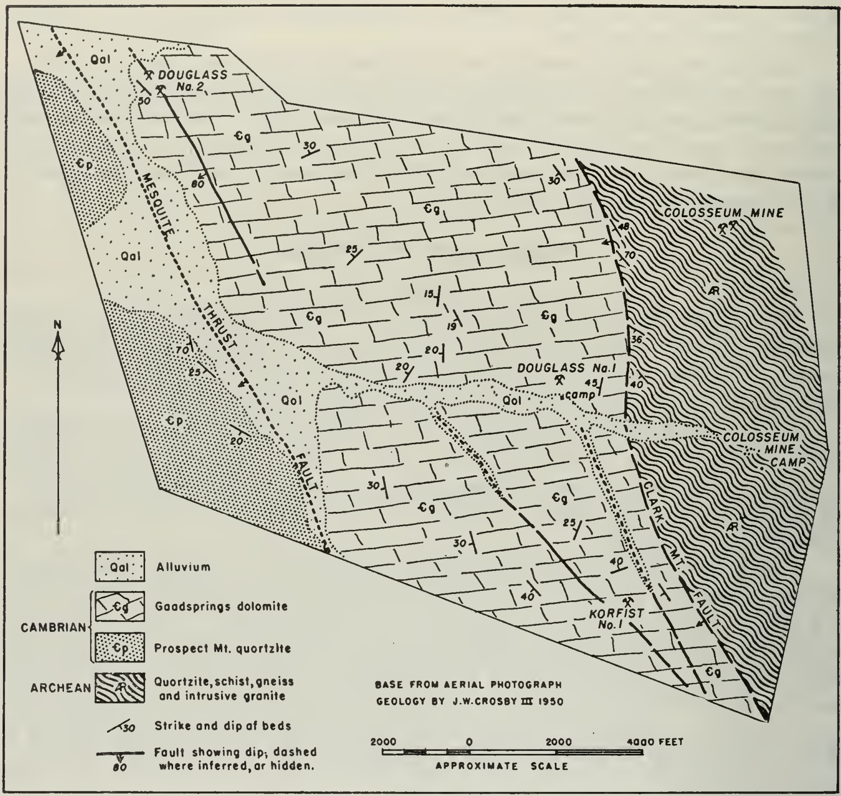
Qal
DOUGLASS No. 2
Єg
Єp
MESQUITE THRUST FAULT
COLOSSEUM MINE
Ar
DOUGLASS No. 1
camp
COLOSSEUM MINE CAMP
CLARK MT. FAULT
KORFIST No. 1
N
Qal Alluvium
CAMBRIAN
Єg Goodsprings dolomite
Єp Prospect Mt. quartzite
ARCHEAN
Ar Quartzite, schist, gneiss and intrusive granite
30 Strike and dip of beds
80 Fault showing dip; dashed where inferred, or hidden.
BASE FROM AERIAL PHOTOGRAPH
GEOLOGY BY J.W. CROSBY III 1950
2000 0 2000 4000 FEET
APPROXIMATE SCALE

FIGURE 2. Areal geologic map of Clark Mountain fluorspar area.

was devoted to laboratory work, and numerous samples of ore and country rock were examined by means of the petrographic microscope.

Geology

Three stratigraphic units were recognized and mapped in the course of this study. They are (1) the Archean complex which is composed largely of granitic rocks, quartzite, gneiss, and schist; (2) the Goodsprings dolomite of Cambrian age which is composed of magnesian limestones and dolomites; and (3) the Prospect Mountain quartzite of Cambrian age which, in this area, is predominantly a medium-grained quartzite.

Two major faults traverse the area and account for the intense brecciation and minor faulting which is prevalent in the rocks of the locality. One fault, the westward-dipping Clark Mountain normal fault, places Archean rocks in contact with the Goodsprings dolomite. The fault trends through the area in a direction about 20° west of north. The other major fault, about 2 miles to the west, is the Mesquite thrust, the trace of which nearly parallels the trace of the Clark Mountain fault. The Prospect Mountain quartzite has been thrust over the Goodsprings dolomite along the westward-dipping plane of the Mesquite thrust. Because of minor faulting and extreme brecciation accompanying these major faults, the stratigraphic relationships are confused and no attempt was made to subdivide the major stratigraphic units.

Archean Rocks. The Archean rocks are in the eastern part of the area. On the west they are limited by the Clark Mountain normal fault, along which they have been brought into contact with the Goodsprings dolomite. The only recognizable sedimentary units of the Archean rocks are quartzites which are most commonly exposed along the trace of the Clark Mountain fault. The quartzites are white to light brown on fresh surfaces and on weathered surfaces are generally light to dark brown. In many places bedding is well defined, and cross-bedding is prominent in other places. The grain size ranges from about $\frac{1}{4}$ millimeter to 2 millimeters, but in many places the quartzite grades into pebble conglomerates in which individual pebbles may reach $\frac{3}{4}$ inch in diameter. The quartzite is composed almost entirely of quartz and chert grains. A small amount of feldspar and magnetite are present in the quartzite and the magnetite has been altered in large part to limonite.

Bedding-plane joints are common in the quartzites, and coupled with numerous other fractures in the rock, tend to promote the formation of massive, blocky outcrops.

The bulk of the Archean is composed of an intrusive complex—chiefly granitic in composition—and schists and gneisses, which may be representative of more than one geologic period. If this is true, the rocks having a well defined gneissic or schistose structure would be assigned to the older group, whereas the rocks devoid of obvious linear elements would be assigned a younger age and may not be Archean.

One of the more noticeable features of the non-linear intrusive rocks in this area is the predominance of microcline which gives to large areas of rock a characteristic pink color. Other minerals in the rock are quartz, albite, muscovite, and biotite. The rocks considered Archean are predominantly biotite-quartz-plagioclase schists and gneisses. The complex is intruded in many places by small dikes of dioritic and basaltic composition. These intermediate and basic dikes have evidently been much less resistant to erosion than the rest of the series because they characteristically mark the presence of saddles and small gullies.

Goodsprings Dolomite. The Goodsprings dolomite has been described in detail by Hewett[4] in his reports on the Goodsprings and Ivanpah quadrangles.

The Goodsprings formation exposed in the Clark Mountain area consists of a northwest-trending belt bounded on the east by the Clark Mountain fault, and on the west by the Mesquite thrust. The stresses during faulting have brecciated and deformed the formation. The shearing action has produced a mass of small and medium-sized faults in the Goodsprings formation in general which constitute two systems, one parallel and the other oblique to the Clark Mountain fault. Large zones of brecciation are to be found all through the formation in this area. The tendency for nearly all mineralized portions of shears to be sharply delimited by cross faulting suggests selective replacement of dolomite within the confines

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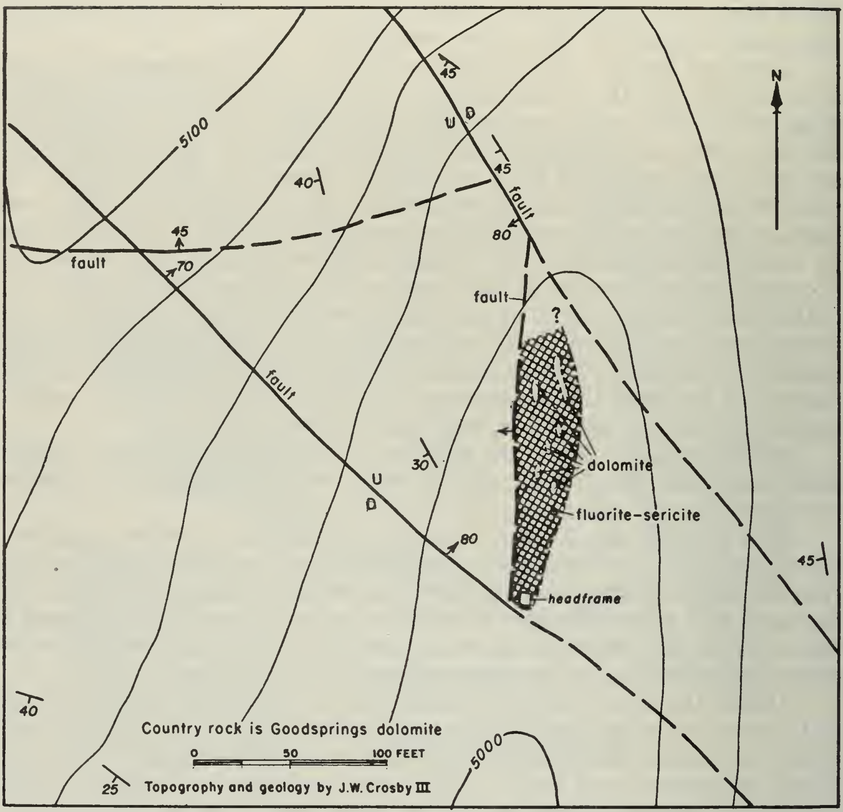
[4] Hewett, D. F., Geology and ore deposits of the Goodsprings quadrangle, Nevada: U. S. Geol. Survey Prof. Paper 162, 1931. Geology of the Ivanpah quadrangle, California and Nevada (in preparation).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headframe
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Country rock is Goodsprings dolomite
0
50
100 FEET
5000
25
Topography and geology by J.W. Crosby III

Figure 3. Geologic sketch map of Douglass No. 1 fluorspar prospect, Clark Mountain, San Bernardino County, California.

of the cross faults, especially because offset segments of the veins cannot be traced.

Both field and laboratory tests have shown that the Goodsprings formation in this area is composed almost entirely of dolomite and high-magnesian limestone. Most of the formation is fine- to medium-grained, but along some shear zones sufficient recrystallization has taken place to produce a very coarse-grained rock. The color ranges from nearly white to dark smoky gray; most of the formation is medium-gray.

At only one place in the area was anything found that could be identified as organic remains, and preservation was so poor that they were of no assistance in age determination.

Prospect Mountain Quartzite. The Prospect Mountain quartzite is exposed in the western part of the area. On the east it is limited by the Mesquite thrust fault along which the formation has been thrust over the Goodsprings dolomite.

The quartzite in this locality is typically medium- to coarse-grained. A dark brown color on weathered surfaces is caused by iron oxides. Some beds are stained so heavily they have a color approaching black, whereas others which are nearly iron-free approach a creamy or whitish color.

Many of the beds contain a high percentage of magnetite which, in part, may have been altered to limonite. With the exception of magnetite the quartzite is composed almost entirely of quartz grains.

Mineralogy and Description of the Ores

The fluorspar ores of the Clark Mountain area are unique in that they are composed predominantly of two minerals: fluorite and sericite. Dr. Adolph Pabst of the University of California made X-ray diffraction patterns of the sericite. He states: "The material is definitely a mica close to muscovite. It is not talc, pyrophyllite, or a related material. No conclusions as to the chemical composition can be drawn from this identification, except that the composition must be such as to be compatible with a muscovite structure." Spectrographic analyses and qualitative chemical tests made in the Division of Mines laboratory conform with Dr. Pabst's conclusions.

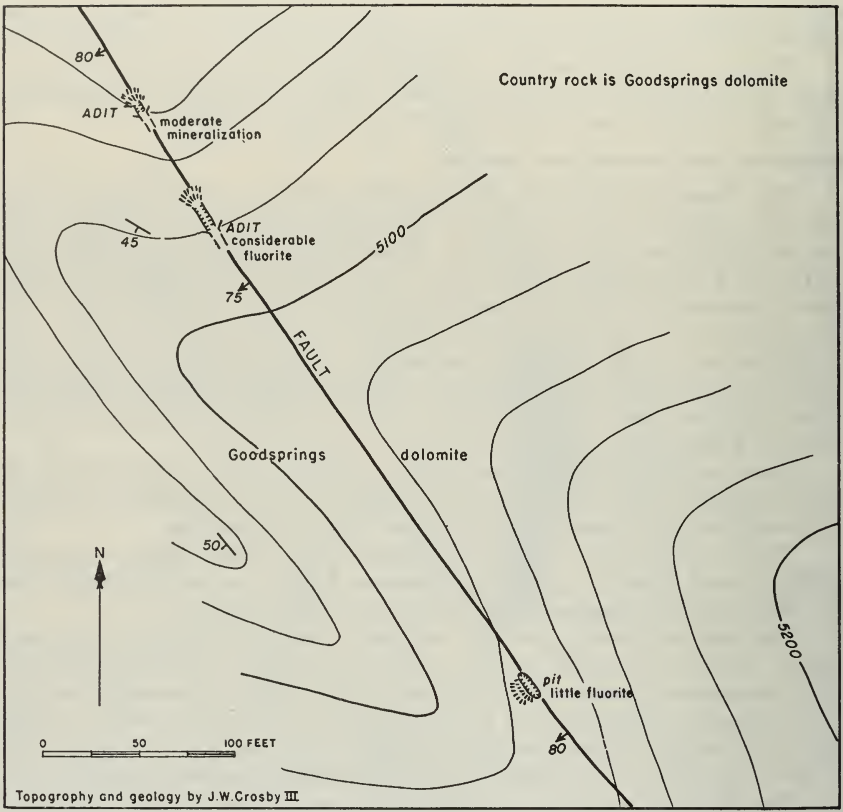
Some of the Clark Mountain ores contain pyrite, which alters to brown limonite. The only other minerals in the ore are quartz—much of it in small veinlets—and blue and green copper carbonates.

The ore has been arbitrarily classified into three types—massive, schistose, and friable. A subtype, massive-friable, is used for ores that are intermediate between the massive and friable types.

The massive type is a tough, compact, grayish-purple ore composed almost entirely of sericite and fluorite. The fluorite content is generally low; the mineral occurs as veinlets and blebs within the sericite gangue. It is probably a replacement of the sericite. The low fluorspar content and the difficulty of breaking the fluorspar away from the sericite gangue do not make these ores amenable to beneficiation except at excessive cost.

The schistose ores are typified by the ore at the Korfist Number 1 property, which averages between 40 and 60 percent fluorite. A distinct foliation that parallels the trend of the vein—apparently indicative of post-mineral movement along the fault—is characteristic of them. These ores also, unlike massive ores, have a greater percentage of pyrite and are stained brown by alteration of pyrite to limonite. Although, like the massive ores, the intimate association of fluorite and sericite in the schistose ores presents problems of beneficiation, it is probable that the ores could be successfully treated by fine grinding followed by flotation. The increased tenor of the schistose ores would make them much more feasible for such treatment than would the massive ores.

The friable ores, exposed in Douglass' Number 2 claim, contain little in the way of minerals other than fluorspar and sericite. The ores are composed of a very white, friable sericite in which are veins and pods of light purple fluorite, with which is associated the massive type of sericite. The ore may contain as much as 50 to 60 percent fluorspar and will disintegrate in water, the sericite forming a suspension the fluorspar settling to the bottom. The fluorspar which settles to the bottom contains a higher percentage of fluorite than massive ore, probably averaging more than 90 percent. These ores would be amenable to the production of metallurgical-grade fluorspar by a very simple beneficiation process. However, the quantity of ore available is probably too small to warrant installation of the necessary equipment.


Country rock is Goodsprings dolomite
80
ADIT
moderate mineralization
45
ADIT
considerable fluorite
5100
75
FAULT
Goodsprings
dolomite
50
N
pit
little fluorite
80
5200
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50
100 FEET
Topography and geology by J.W.Crosby III

FIGURE 4. Geologic sketch map of Douglass No. 2 fluorspar prospect, Clark Mountain, San Bernardino County, California.

The subtype of ore—massive-friable—is characterized by that at the Douglass' Number 1 property. This type of ore is composed of bodies of massive fluorspar-sericite. Much of this material will disintegrate in water, but not sufficiently for beneficiation. The average tenor of the ore is 50 to 60 percent fluorite, and like the schistose ore, it is probably amenable to treatment by fine grinding and flotation, providing sufficient reserves could be established to warrant the expense of installing the necessary equipment.

Ore Deposits. The fluorspar deposits of the Clark Mountain area represent local replacement bodies along fissures in the Goodsprings dolomite. Many of the fissures are mineralized to some extent as shown on the map (fig. 4), but very few warrant exploratory work.

At the Korfist Number 1 property an 85-foot shaft facing south at a 60° incline has been completed. The top 50 feet is in fluorspar. Two drifts, one 40 feet due west and the other 30 feet due south, were driven at the 50-foot level. Fluorspar was encountered in both drifts and the sut south drift was halted with dolomite on the footwall. Approximately 100 feet east of the shaft are five pits, from 5 to 10 feet deep, exposing fluorspar. The vein is about 40 feet wide on the surface at this point. The Korfist ore body apparently is limited by faults within short distances in both directions along the strike (pl. 47). Attempts have been made to trace extensions of the ore by searching for float, but none has been found. It would therefore appear that the fluorspar ore is restricted to a small area, but additional development work is necessary before accurate predictions can be made.

The ore body at the Douglass' Number 1 property is a replacement of the dolomite underlying a small thrust fault. The ore is capped by a gouge zone composed of brecciated and sugary dolomite. Where exposed, the gouge is friable and can be dug easily with a pick. However, it has apparently been an impervious barrier to the mineralizing solutions because the fluorspar is confined to the lower few inches of the gouge and to the underlying dolomite. Associated with the ore are numerous horses of dolomite which have recrystallized to coarse-grained marble.

The Douglass' Number 1 ore body is exposed for approximately 200 feet along the strike and is faulted off on both ends. To the south it is impossible to trace extensions because of the thick valley wash. To the north, however, the thrust fault is again exposed in an upthrown segment, but no ore was seen. The maximum thickness of the fluorspar-bearing zone is about 10 feet, but its limits, extending along the strike, do not allow much hope for the development of reserves.

The Douglass' Number 2 ore body is perhaps the most promising of the area. The ore has been exposed by cuts at several places along a nearly vertical fault. In one adit the ore apparently contains 50 or 60 percent fluorspar, but in the other exposures the fluorite content is much less. The vein, where it is exposed, ranges between 4 and 5 feet in thickness, and contains small horses of dolomite and dolomitic breccia fragments which have not been replaced by the mineralizing solutions. The vein pinches and swells along the strike. The shear zone in which the ore bodies occur can be traced for nearly a mile, but thus far ore has only been found at the northwestern end of the fault. It is possible that additional ore shoots will be found with more extensive development.

Conclusions. Fluorspar deposits in the Clark Mountain area are widely separated and appear to be limited in size. It is likely that a small amount of fluorspar can be obtained by selective mining followed by hand-sorting. However, insufficient fluorspar is in sight at present to warrant the installation of a plant to concentrate the ore.

The abundance of sericite in the ore bodies of the Clark Mountain area may warrant further investigation. It is possible that this material may be a satisfactory substitute for finely ground mica which now is prepared by the grinding of scrap muscovite at considerable cost. The friable fluorspar-sericite ore would be especially suitable and if the material would prove to be a satisfactory substitute for ground mica, fluorspar could be obtained as a by-product at very little additional cost.

Other Deposits

Warm Spring Canyon Deposit. The Warm Spring Canyon deposit, comprising four claims, is on the east slope of the Panamint Mountains, 48 miles by road from Shoshone. A dirt road turns off from the Death Valley west road and runs up Warm Spring Canyon to the lower adit of the mine. The owner of the claims is Owen Montgomery, Death Valley, California.

Fluorite veins ranging in width from 1 foot to 10 feet are associated with quartz in pre-Cambrian (?) quartz-muscovite gneiss. The fluorite is apparently associated with shears trending in the same direction as the vein system (strike N. 40° E., dip 40°-60° NW.). Minor cross-shears are also present. One vein is exposed for more than 400 feet on the surface. Three adits have been driven for a total length of about 700 feet.

White Mountain Deposit. This deposit is about 14 miles west-northwest of Bishop in sec. 33, T. 6 S., R. 35 E., M. D. It is owned by George A. McAfee and Louie Stewart of Bigpine. Two claims, the Fluorite Number 1 and the Fluorite Number 2 have been filed. The fluorspar occurs in small fissures in limestone and as disseminated crystals in several dikelike epidote tactite bodies present in the area. The strike of the fissures ranges from N. 10° E., to N. 40° E., the dip is usually vertical or nearly so.

The mineralized zones along the fissures are unusual and appear to be the result of pegmatitic emanations reacting with limestone. The veins are banded. Near the wall rock there is a zone consisting of a fine-grained mixture of quartz and fluorite. Next is a well-defined zone of coarsely crystalline muscovite, composed of individual cleavage plates as much as 1¼ inches in diameter, averaging about ¾ inch. Occupying the center portion of the vein is very pure, dark purple fluorite. The maximum width of the fluorite in the center of the vein is seldom more than 3 inches. The border zones of quartz and fluorite are as much as 8 or 10 inches wide.

The largest vein in the area strikes N. 30° E. and dips 75° W. Its maximum width is about 2 feet, but it can not be traced for more than 20 feet on the surface. The veins have been explored by a series of small trenches.

Although some high grade fluorspar has been uncovered in this area, the small size of the veins will probably prohibit development of the property.

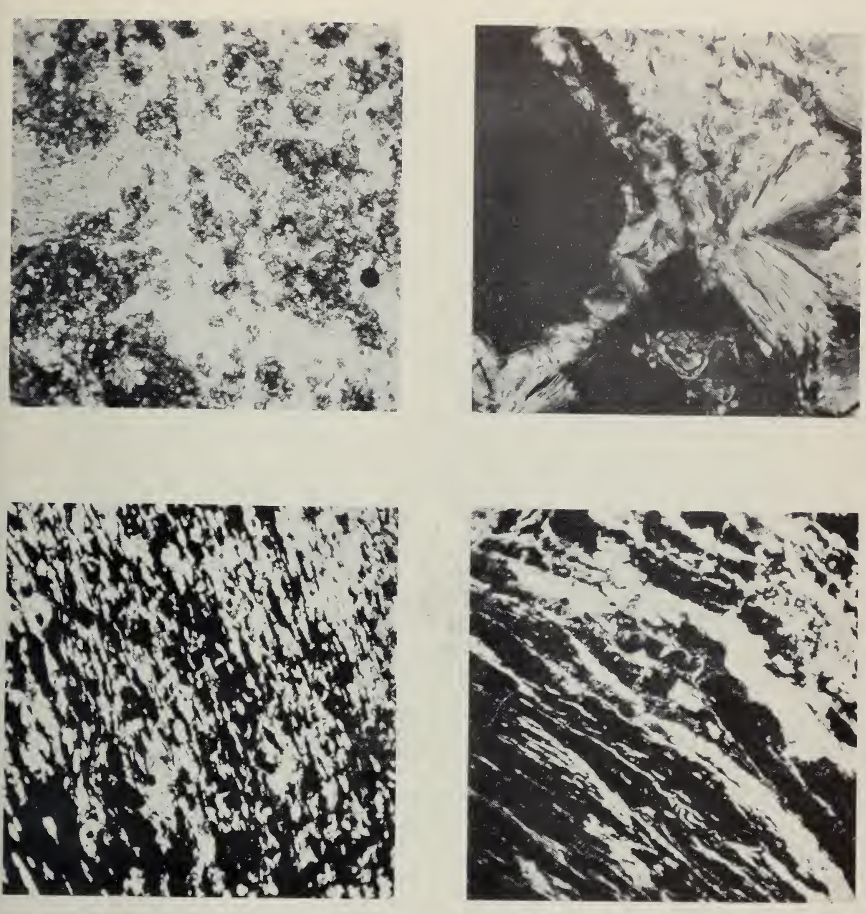
Last Chance Canyon Deposit. This deposit is located in the El Paso Mountains, in sec. 12 (approximately), T. 29 S., R. 38 E., M. D. The owners are Della Gerbracht and R. L. Meur who live near the deposit.

Several veinlets are present in a shear zone about 8 inches wide. The shear zone strikes N. 55° E. and dips vertically. Country rock in the immediate area is a meta-rhyolite; adjacent to the deposit, the country rock has been hydrothermally altered producing a talcose and sericitic rock. The fluorspar is multi-colored, red, green and white.

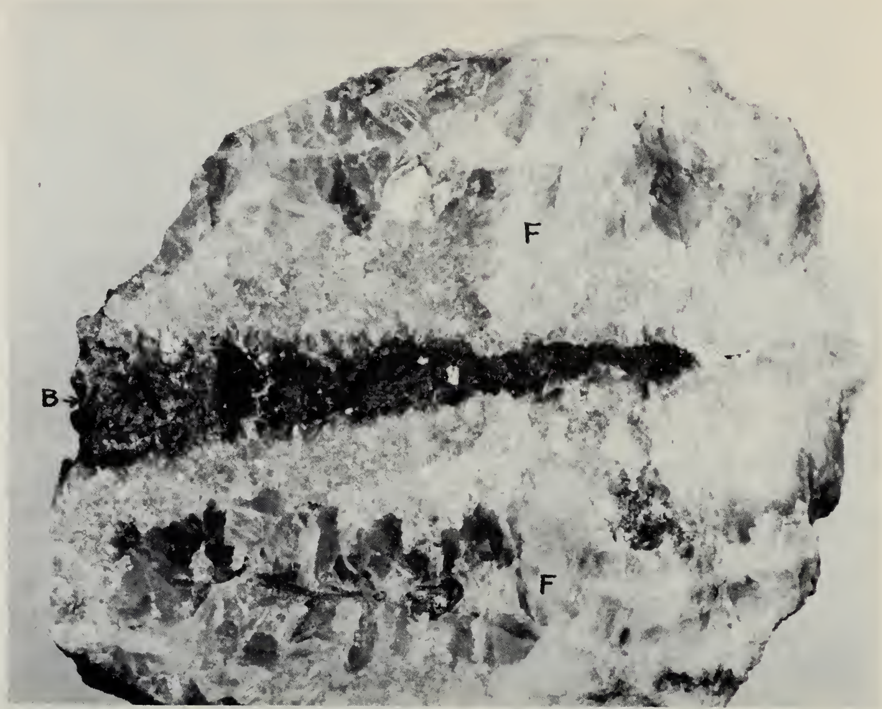
No production is foreseen from this deposit.

Fluorspar Group Deposit. The Fluorspar Group comprises five claims situated on the north end of the Palen Mountains, 1 mile southwest of Packard's Well, in sec. 4, T. 3 S., R. 18 E., S. B., 18 miles northwest of Midland. Owners are Louis Favret and L. H. Raines, Blythe, California, and N. A. Anderson, Pasadena, California.

The country rock is monzonite. The fluorite-bearing vein, 5 feet in width, strikes N. 65°E. and dips 45°N. White, green, and purple fluorspar

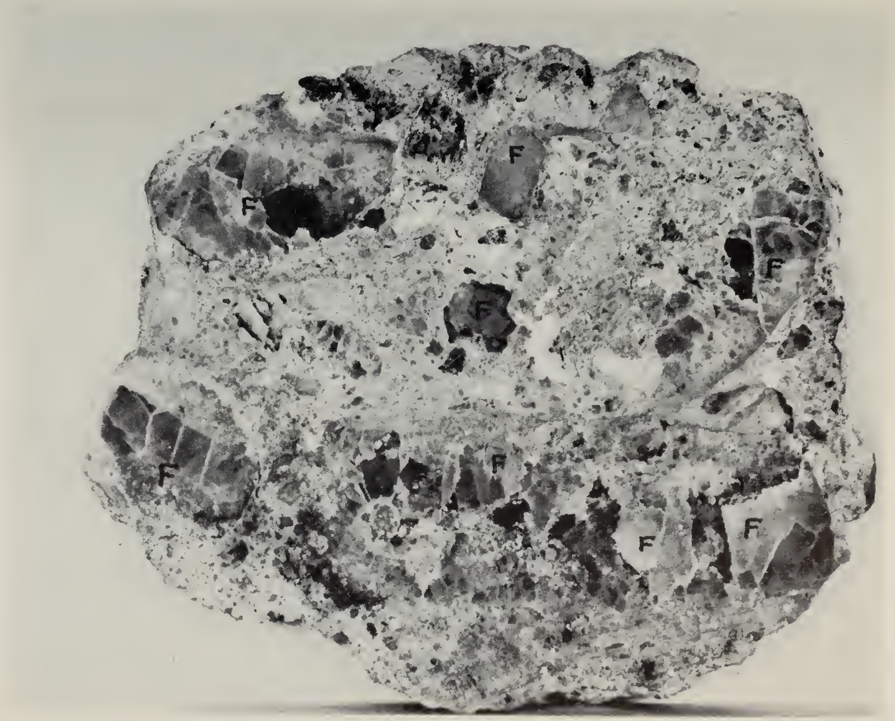


A, PHOTOMICROGRAPH OF ORE FROM AREA NORTHWEST OF KORFIST SHAFT. Photo shows fluorite (black) blebs in gangue of sericite (white). Crossed nicols. *B*, PHOTOMICROGRAPH OF ORE FROM AREA NORTHWEST OF KORFIST SHAFT. Photo shows fluorite (black) bounded by recrystallized sericite (white). Crossed nicols. *C*, PHOTOMICROGRAPH OF ORE FROM KORFIST'S MAIN INCLINE. Photo shows fluorite (black) associated with sericite (white). Note the lineation in the ore. Crossed nicols. *D*, PHOTOMICROGRAPH OF ORE FROM THE DOUGLASS NO. 1 PROPERTY. Photo shows fluorite (black) associated with sericite (white). Crossed nicols.

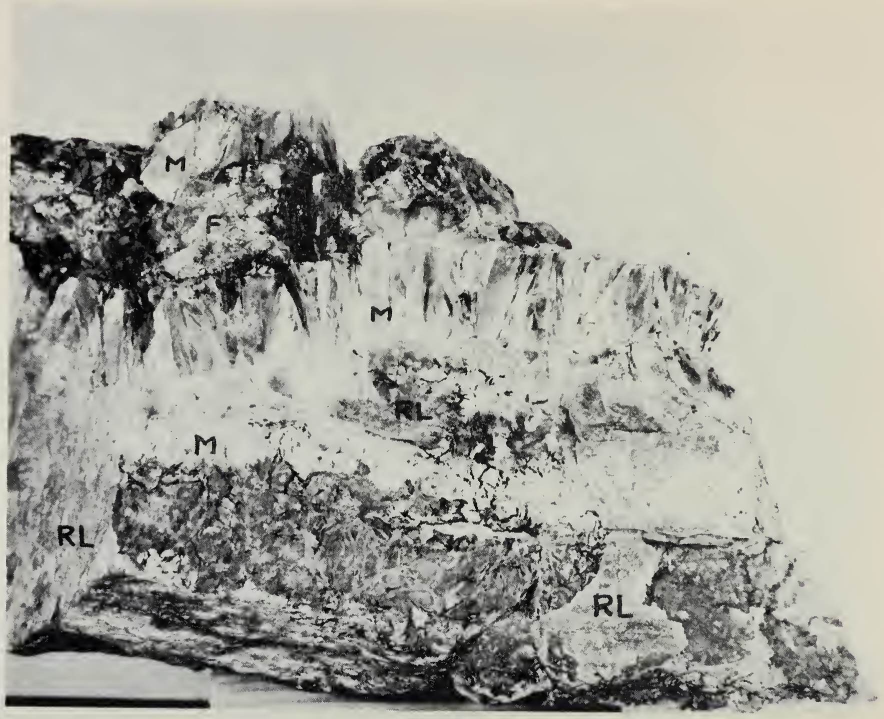


VEIN FLUORSPAR FROM THE BIG HORN NUMBER 9 CLAIM

Afton Canyon area, San Bernardino County. Fluorite (F) is coarsely crystalline, green in color and includes a narrow breccia zone of calcite and colorless fluorite. Scale is full size.



FLUORSPAR (F) IN ANDESITE BRECCIA
From Afton Canyon area, San Bernardino County. Scale is full size.



FLUORSPAR FROM THE WHITE MOUNTAINS DEPOSIT, INYO COUNTY

Fluorite (F) is pale to dark purple in color and occurs as veins with coarse muscovite (M) and also as fine-grained replacement in limestone wallrock (RL). Scale is three-fourths size.

occurs in bunches and is disseminated in the gangue, intimately associated with malachite, azurite, calcite, and quartz.

Development consists of an open cut 100 feet in length, 5 feet deep, and 5 feet wide.

Red Bluff Deposit. This deposit comprises 8 claims located as Red Bluff No. 1 to No. 7, and Lucky Day, situated on the east slope of the Little Maria Mountains, in sec. 27, T. 3 S., R. 20 E., S. B., about 3½ miles northeast of Midland.

A series of roughly parallel veins of fluorspar occurs in quartzite and mica schist. The veins strike N. 50° W., dip 75° N., and range in width from 18 inches to 3 feet. Development on the Red Bluff vein consists of a shaft sunk to a depth of 30 feet. This shaft developed a lens of fluorspar about 40 feet in length and 2 to 4 feet in width. To the northwest of these workings there is a trench 50 feet in length which exposes 12 to 18 inches of fluorspar. At a higher elevation, a shaft has been sunk to a depth of 30 feet on a vein which strikes N. 30° W. and dips 70° E. Width of the vein is 2 to 4 feet. Here there is also a vein that strikes N. 50° W.

One hundred and thirty tons of fluorspar was mined in 1944 and shipped to Torrance. Analysis showed 87 percent CaF_2, 4 percent SiO_2, 0.47 percent CaO, 2.25 percent Al_2O_3, and 0.15 percent Fe_2O_3.

Afton Canyon Deposit. The Afton Canyon fluorspar area is in secs. 4, 5, and 7, T. 10 N., R. 6 E., and sec. 3, T. 11 N., R. 6 E., S. B. It is about 3 miles south of Afton, a station on the Union Pacific Railroad.

Two fluorspar-bearing zones are present in the area, separated from each other by about 1½ miles. The first of these zones has been staked in part by Ora E. Whitlock, the name of the claim being the Big Horn Number 9. It is likely that other claims are present, but the markers have apparently long since been destroyed.

The fluorspar occurs in veins and breccia zones in andesite and basalt. The attitude of the veins is somewhat variable, but in general they strike N. 70° E. and dip vertically. The veins range from ½ inch to 8 inches in width. Quartz, calcite, and siderite are the associated gangue minerals. Apparently the fluorspar was the last mineral to be introduced as it characteristically occupies the center portion of the veins. The fluorspar occurs in a zone about ⅛ mile wide and approximately 1 mile long. No single vein is extensive over any great distance, but there is a tendency for the veins to form en echelon making the fluorspar more or less continuous throughout the zone. If commercial production were to be undertaken in this area, it is likely that the operation would have to be a large-scale stripping operation, and it is doubtful that the tenor of the ore would support such an enterprise.

Fluorspar has been produced about 1½ miles to the west-southwest of the above area. A shaft was sunk to a depth of about 150 feet on a vein which strikes S. 80° E., dips vertically, and has a maximum width of 4 feet. The tonnage of fluorspar produced and the ownership of the property are not known. Fluorite is in a gangue of quartz and calcite. The western portion of the mineralized fissure has an andesite foot and hanging wall, whereas the eastern portion has a hanging wall of granite and a footwall of andesite. The writers were not able to go down in the shaft to learn

Tabulated list of fluorspar properties in California.

Claim	Last known owner	Sec.	T.	R.	B&M	Remarks and references
Inyo County						
Fluorite #1 & #2 (White Mountain)	George A. McAfee and Louie Stewart, Bigpine	33	6S	35E	M.D.	
Warm Spring	General Chemical Division, Allied Chemical and Dye Corp., 40 Rector St., N.Y., N.Y.	—	22N	1E	S.B. proj.†	R34:483-484; herein
Wine Fluorspar	Wade H. Wine, 2165 Plumas St., Reno, Nevada	13?	19S	44E	M.D. proj.†	Fluorspar in dolomite (?); worked by shallow inclined shaft
Kern County						
Last Chance Canyon	Della Gerbracht, R. L. Meuer	12?	29S	38E	M.D.	Herein
Riverside County						
Fluorspar Group	Louis Favret, L. H. Raines, Blythe, and N. A. Anderson, Pasadena	4	3S	18E	S.B.	R25:470; B50:343; herein
Afton Canyon	Essential Mineral Co., 617 Black Bldg., Los Angeles	4, 5, 7, and 3	10N 11N	6E 6E	S.B. S.B.	Burchard, E. F., A.I.M.E. Trans., vol. 109, pp. 373-374; herein
Big Horn #9 (Afton Canyon)	Ora E. Whitlock	------	10N	6E	S.B.	Herein
Free Thinker or Magna #1	H. C. Moore, 1958½ Rodney Dr., Los Angeles	------	28S	16E	S.B.	R27:376; herein
A. L. French (Ivanpah Mountains)	A. L. French	------	14N	14E	S.B.	Herein
Green Hornet	Mrs. L. B. Garvell, 2580 Lincoln Blvd., San Bernardino	7, 8	6N	1W	S.B.	Herein
Korfist (Clark Mt.)	Jerry Korfist, Baker	------	17N	13E	S.B.	Herein

Live Oak	Emily R. Ball and heirs of E. H. Hunting and Lola May Adams	------	14N	16E	S.B.	Herein
McKinney	C. J. McKinney, F. C. Snyder, and D. R. Brown, Victorville	1	6N	1W	S.B.	Herein
Philadelphia (Providence Mountain)	Oscar L. Hoerner, Newberry	------	9N	13E	S.B.	R27:376; herein
Primer	George B. Primer, Lancaster	26	7N	6W	S.B.	Herein
War Eagle (Clark Mt.)	Gilbert W. Douglass	------	17N	13E	S.B.	Herein
			Tulare County			
Annie J. Nash, Camp Nelson, and V. K. Porterville	----------	34	20S	31E	M.D.	R26:439

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† Public land survey lines are not complete on the base map.

* The following abbreviations for Division of Mines publications in this column: R—Report of the State Mineralogist; B—Bulletin. The number following the colon in such references is the page number.

whether or not there had been any drifting on the vein. A short distance to the west of the shaft the fault is mineralized entirely by calcite, at places being as much as 15 feet wide. To the east of the shaft the fluorite-bearing zone appears to pinch out entirely.

The vesicles of some of the basalt exposed at the surface near the shaft are filled with fluorspar.

Ivanpah Mountains Deposit. The A. L. French fluorspar deposit is in the Ivanpah Mountains in sec. 8 (approximately), T. 14 N., R. 14 E., S. B. The prospect is not likely to develop into a commercial ore body.

The fluorspar is present in minute shears in a partly sericitized quartz monzonite porphyry, and wholly or partly replaces many of the phenocrysts of the rock. The fluorite is dark purple and is in sharp contrast to the more subdued color of the country rock.

The mineralized area is irregular in shape, and is about 75 feet across in its greatest dimension. The deposit has been explored by a small trench and a discovery hole.

Because the fluorite content of the rock is low and the extent of the deposit small, little development work is likely to be undertaken.

Green Hornet Deposit. The Green Hornet deposit comprises 17 claims situated in secs. 7 and 8, T. 6 N., R. 1 W., 16 miles northeast of Lucerne P.O. and 30 miles by road northeast of Victorville. Mrs. L. B. Garvell, 2580 Lincoln Boulevard, San Bernardino, California, is the owner.

Five parallel quartz veins 4 to 6 feet wide occur in granite. The veins strike east and dip 80° S. Fluorite occupies irregular lenses in the quartz veins.

Development is confined to quartz veins about 40 feet apart. A shaft has been sunk on one of the parallel veins to a depth of 80 feet. On the 80-foot level a drift has been driven east 125 feet. About 100 feet along the drift a crosscut has been driven 40 feet north to intersect a parallel vein. In the east drift several small lenses of fluorspar about 10 feet in length were mined. It is estimated that there is on the dump about 2000 tons of ore reported to carry 40 percent CaF_2. Ten tons of sorted ore is reported to carry 85 percent CaF_2 and 12 percent silica.

Live Oak Mine. The Live Oak Mine is in the New York Mountains in T. 14 N., R. 16 E., S. B. It is about 14 miles southeast of Ivanpah. The mine is owned by Emily R. Ball and the heirs of E. H. Hunting and Lola May Adams.

The vein has a strike of N. 20° W. and dips 75° S. The footwall is granite of Jurassic (?) age and the hanging wall is an alaskite dike which has intruded the granite and Cambrian (?) limestone. Several small tactite bodies have been formed between the limestone and alaskite dike.

Fluorspar is associated with quartz, pyrrhotite, pyrite, chalcopyrite, covellite, calcite, sphalerite, galena, and the secondary minerals malachite and limonite. Some fluorite and sulfides are disseminated in the alaskite hanging wall and the granite footwall. Several smaller fissures striking N. 10° E. and dipping 75° E. are also mineralized.

The maximum width of the vein is about 12 feet. Zoning is prominent. Fluorite and sulfides are concentrated near the vein walls, and quartz, or quartz and fluorite, fill the central portion of the vein.

The fluorite content of the ores at this property probably averages about 40 percent. It is impossible to estimate ore reserves as only several hundred feet of development work has been done. It is likely, however, that acid-grade fluorite could be produced as a by-product of a flotation mill providing the sulfides in the ore would warrant the necessary installation costs.

McKinney Deposit. This deposit comprises two claims on a low range of hills a mile south of the Gold Belt mine, in sec. 1, T. 6 N., R. 1 W., S. B., 27 miles by road east of Victorville, California.

A quartz vein 6 feet wide occurs in granite. The vein strikes east and dips vertically. A 6-inch streak of purple and green fluorspar occurs on one wall of the vein, in 4 feet of quartz mixed with fluorspar. About a quarter of a mile south is a parellel vein of quartz containing fluorspar. Development consists of a 10-foot shaft and an incline shaft 55 feet in depth.

Nipton Deposit. The Free Thinker, or Magna Number 1, fluorite claim is in T. 28 S., R. 16 E., S. B., about 3½ miles west of Nipton. It is owned by H. C. Moore of 1958½ Rodney Drive, Los Angeles.

Country rock in the area is predominantly Archean augen gneiss, but some Archean quartzite is also exposed. Several small veins have been explored by cuts and adits, and a small amount of fluorite from these excavations has been stock piled.

The largest of the exposed veins has a maximum width of about 18 inches and was traced for about 40 feet along its strike. Most veins pinch out a short distance along the strike, and it is likely that they behave similarly in the direction of dip. The strike and dip of the veins vary widely and do not appear to represent any clearly defined system.

Fluorite is associated with quartz, iron oxides, and carbonates of copper. Much of the ore would meet metallurgical-grade specifications if it were hand-sorted.

It is unlikely that any large tonnage of fluorspar could be developed at this property. However, a small amount of shipping-grade material could undoubtedly be obtained by selective mining and hand-sorting.

Primer Deposit. The Primer deposit comprises three claims on the northeast slope of Shadow Mountain in the Silver Mountain mining district, 8 miles northwest of Adelanto in sec. 26, T. 7 N., R. 6 W., S. B. George B. Primer, Lancaster, California, is the owner.

Discontinuous stringers and pockets of light green fluorite are associated with white, transparent calcite crystals in hydrothermal fissure veins in gray limestone. Some limonite and a small amount of quartz are present. The veins strike N. 5°-20° E., dip 45°-60° W., and range in size from several inches to 4 feet in width.

A shaft has been sunk on a fissure to a depth of 15 feet. A 30-foot open cut and two trenches about 45 feet long complete the development work.

Providence Mountain Deposit. The Philadelphia fluorspar claim is in the Providence Mountains, in T. 9 N., R. 13 E., S. B. It is owned by Mr. Oscar L. Hoerner of Newberry, California.

The deposit consists of a single vein having a maximum width of about 6 feet and an exposure of about 50 feet along the strike. There is some reason to believe that it may be terminated by a fault and that extensions may be found.

The only fluorite observed outside the limits of the main vein was in a small gully just north of the end of the main mineralized zone. In this gully a few small veinlets containing fluorite were found.

With the exception of a small amount of quartz gangue, the vein is composed of nearly solid fluorite. The mineralized fissure is localized in a fine-grained granite which makes up part of an extensive granitic complex.

About 20 tons of 50 percent fluorite was on the dump early in 1950. The fluorspar is of good grade and, if a sufficient tonnage of ore could be developed, the property might produce on a commercial basis.

INDEX TO VOLUME 47

Chapter 1, January 1951, includes pp. 1-224.
Chapter 2, April 1951, includes pp. 225-464, Supplement, pp. 1-115.
Chapter 3, July 1951, includes pp. 465-552.
Chapter 4, October 1951, includes pp. 553-680.

CONSOLIDATED TABLE OF CONTENTS

Limestone in the California beet sugar industry, pp. 9-16.
Mines and mineral resources of Inyo County, pp. 17-223.
Annual report of the State Mineralogist, pp. 233-270.
Counties of California—mineral production and significant mining activities of 1949, pp. 271-464.
Supplement, Publications of the California State Division of Mines to March 1, 1951, pp. 1-115.
Mineral needs and problems of the bituminous base roofing industry, pp. 473-483.
Mines and mineral resources of Fresno County, California, pp. 485-552.
Mines and mineral resources of Contra Costa County, pp. 561-617.
Fluorspar in California, pp. 619-638.
Index to volume 47, pp. 639-680.

INDEX

A

A and E Readimix Company, 324
Abbott mine, 331, 332
Abeil, Robert Lee, 512
Abrasive stone (pebbles for grinding), 276
Academy granite, 504; Company, 504
Ace High Mining Corporation, 371
Adams, Lola Mae, 634
Adams, R. W., 97
Adamson, D. B., 86
Adamson, Roy, 87
Adamson mine, 86
Aeroplane mine (see Standard Tungsten Company mill), 88
Afterthought mine, 370
Afton Canyon, 619
Afton Canyon deposit, 633
Aggrelite Company, 332
Agricultural Mineral and Fertilizer Company, 506
Aguereberry, Ambroise, 44, 46
Aguereberry, J. P., 44
Aguereberry Point, 44
Airox Company, 365
Alabama claim, 78
Alameda County, 9, 15, 273, 309, 310, 563, 564, 565; bromine, 276; clay, 277; lime, 281; magnesium compounds, 281; salt, 284; sand and gravel, 284; stone, 286
Alaska, 481
Alberhill Coal and Clay Company, 351
Alberta mine, 116, 122
Alberta property, 114
Albertoli, Morris, 43, 45, 57, 58, 105
Albion Pottery Company, 571
Alcalde Ridge, 490
Alder Creek, 354
Alexander mine (see Shoshone Mines), 80
Alhambra group, 576

Alhambra Springs, 576
Alleghany district, 280
Allen, B. L., 52
Allen and Reddy, 380
Alliance mine, 114, 116, 118
Allied Chemical and Dye Corporation, 603
Allison sands, 518
Alloy Mining Company, 358
Almaden, 285
Almanor Dam, 350
Almeida, A. J., Ranch, 345
Alpine County, 310 ; sand and gravel, 284 ; sulfur, 286 ; tungsten, 287
Alpine Gravel Plant, 312
Alpine Mining Company, 310
Alvarado, 9, 10, 15
Alvernez, M., 578
Amador County, 310-312, 315, 384, 573, 604 ; clay, 277 ; coal, 278 ; copper, 278 ; gold, 279 ; lead, 281 ; pumicite, 284 ; silver, 285 ; stone, 286
Amargosa Range, 21, 54, 103, 114, 124, 125
Amargosa River, 129
Amargosa Valley, 128
Amerada area, 518
Amerada Petroleum Corporation, 361, 521
American Metals, Inc., 60
American Mineral Company, 330
American Perlite Corporation, 598
American Petroleum Corporation, 591
American Potash and Chemical Company, 283, 356
American Radiator and Standard Sanitary Manufacturing Company, 572
American River, 320, 321, 353
American Silver Corporation, 55, 56, 78
American Smelting and Refining Company, 41, 47, 71, 335, 338, 358, 562, 594
American Society for Testing Materials, 475, 478
Anaconda Copper Mining Company, 9, 55, 59, 64, 68, 80, 280, 327, 328
Ancho Erie mine, 347
Ancho Erie Mining Company, 347
Anderson, Hal, 528
Anderson, J. C., 528
Anderson, N. A., 632
Anderson, Robert, cited, 491
Anderson, Stewart, 119
Anderson Rock Company, 322, 503, 528
Andreis, John, 504
Anita mine (see Rita or Santa Reta), 511
Antelope Materials Company, 330
Anthony, C., 45
Anthony group (see Knob group), 45
Antimony, 276
Antimony Ridge, 37
Antioch-Marchio, 581
Antioch quadrangle, 577
Antioch Sand Company, 580
Anvil Canyon, 114
Apex Consolidated group (see Shoshone Mines), 80
Arambide mine, 511
Arando (see Arondo) mine, 38, 327
Arcata Sand and Gravel Company, 325
Archean, 28, 626, 627, 637
Archer Mining Company, 510, 511
Argenta mine, 56
Argo mine, 338
Argus Range, 18, 20, 21, 28, 38, 41, 53, 68, 69, 71, 73, 75, 81, 82, 84, 100, 101, 131, 326, 328
Aries Consolidated group (see Cerro Gordo mine), 58
Armagh mine (see Cerro Gordo mine), 58

Arnold, Emory, 101
Arnold, James, 37
Arnold, Ralph, cited, 591
Arondo mine, 38, 41
Arrastre Springs, 47
Arroyo Nicasio, 337
Arroyo Seco Ranch, 312
Arroyo Valle Creek, 309
Asbestos, 276
Ashford, Harold, 39
Ashford mine, 39
Asphalt, native, 276
Associated Oil Company, 562, 602
Atchison, Topeka, and Santa Fe Railway, 507
Atkinson pit, 349
Attas silica quarry, 357
Attaway, Ed, 52
Auberry, 502
Auburn Lime Products Company, 320
Aubury, Lewis E., cited, 37
Aurora mine, 355
Austin, B. C., cited, 59
Austin, F. L., 49
Austin, Harry, 368
Avawatz Mountains, 21
Avenal Gap mine, 331
Avenal sandstone, 520
Averill, C. V., cited, 482
Avery, Judge Russ, 38

B

B and B Sulphur Company, 113
Babcock, J. E., estate, 95
Babineau, Henry, 109
Bâby, Frank, 80
Bachler and Piedra Magnesite Company mine, 510
Bagdad Chase (see Roosevelt) mine, 358
Bagley, 384
Bagley, R. H., 117
Bailey, Gilbert E., cited, 128, 129
Bailey, Wm. C., cited, 383
Bailey Ranch deposit, 578
Baker Creek, 86
Baker, David, 75, 92, 93
Baker mine, 329
Baker Trucking Company, 380
Bakersfield-Coalinga area, 602
Bakoch group, 86
Bakoch, Nick, 86
Balch Camp, 532
Bald Eagle mine, 352
Bald Eagle Mountain, 352
Ball, Emily R., 634
Ball, N. M. Sons, 585
Ball, S. H., cited, 22
Ballarat, 21, 40, 45, 47, 51, 53, 72, 100, 101
Bancroft, H. H., cited, 588
Barite, 276
Barnes, Andrew G., estate, 36
Barneyback, R. S., 587
Barnsdall Oil Company, 321, 518
Baroid Sales Division, National Lead Company, 357
Barrett mine, 338
Barsigian, F. M., cited, 481, 482
Barstow area, 356

Basalite, 362
Basalt Rock Company, 337, 345, 346, 362, 377, 580
Base Materials Company, 378
Basin Range province, 18, 20
Bastanchury, G. A., Mrs., 36
Bastanchury, Ruth F., 36
Bateman, Paul C., cited, 23, 37, 85, 86, 90, 91, 92, 93, 94
Baum, N. W., 108
Baziok and Beziuk (see Quigley Kings River mine), 532, 533
Bean and Armstrong Mining Company, 350
Bear Creek, 339
Bear River Sand and Gravel Company, 349
Beatty, R. S., 29
Becker, Gus E., 503
Bedell, Stuart, 96, 99
Beerman and Jones, 385
Bekins, Floyd R., 95
Belden mine, 312
Belper, Mr., 9
Belyea, Brinn W., 36
Belyea, B. W., Mrs., 29
Benner, Dorothy, 111
Bennett dragline dredge, 382
Bennett, Mrs., 532
Bennett, Perry, 382
Benoist, M. L., 381
Benson, Alfred, 531
Benson gravel pit, 346
Benson scheelite prospect, 531
Bent Company, 323, 503, 528
Benton Pumice Company, 342
Benware, G. E., 87
Berg, Henry, 355
Berkeley Hills, 585
Bernon mine (see Darwin mines), 59, 64
Bertha claim, 52
Best (see Royal) mine, 314
Best Mines Company, 371
Bethel Island, 594
Betty Ann claim (see JDG Marble Claims), 102
Beverly Onyx-Marble Company, 101
Bidwell, R. W., 108
Big Creek, 507
Big Dyke mine, 330
Big Four mine, 57
Big Horn No. 9, 633
Big Iron Nos. 1 to 3, 54
Big Oak Flat, 385
Bigpine, 20, 86, 99, 104, 105, 113, 116, 121, 327, 632
Big Pine Creek, 86, 116
Big Pine kaolin deposit (see Nebicite feldspar kaolin deposit), 99
Big Shot (see Round Valley) mine, 94; Nos. 1 to 6 claims, 94; Placer No. 1, 94
Big Slide mine, 338
Big Talc claim, 127
Birkhauser, Max, cited, 517
Bishop antimony mine, 28; mill, 97
Bishop Concentrate and Cleaning Company, 87
Bishop Creek, 22, 29, 88, 94
Bishop district, 19
Bishop Engineering and Construction Company, 112
Bishop quadrangle, 21
Bishop tuff, 110
Bishop Tungsten Company, 90; Mines mill (see Bishop Concentrate and Cleaning Company), 87
Black Canyon group (see Black Canyon mine), 57

Black Canyon mine, 57
Black Canyon Spring, 57
Black Diamond mine, 571, 583, 590
Black Diamond bed, 590
Black Dream (see Wingate Wash manganese deposit), 84
Black Eagle mine, 352
Black Hills mine, 312
Black Mountains, 39, 108, 128, 337
Black Prince mine (see Shoshone Mines), 80
Black Rock mine, 329, 343
Blackstone mine, 316
Blake Brothers, 318, 585, 586; mine, 585
Blas Asbestos Corporation, 369
Blossom, Louise, 103
Bloyed, Ed, 312
Blue Bell group, 332
Blue Bird group (see Red Eagle group), 79
Blue Diamond Corporation, 333
Blue Goose quarry, 334
Blue Ribbon mine, 338
Blue Star Mines Ltd., 116, 117, 118, 127, 327
Blue Star Mining Company, 112, 119
Blue Star talc mine, 116
Blue Stone mine, 114, 117
Bluff group (see Cerro Gordo mine), 58
Bob Cat claims, 117
Bohr deposit, 505
Bonham, William, 116, 122, 327
Bonthrone, Mrs. Mary M., 113
Boorman Pumice Products Company, 341, 374
Boron, 329
Boron minerals, 276
Boston claim, 59
Boushey Silver (see Cerro Gordo mine), 58
Bowen, Charles, 343
Bowers Hill, 330
Boyles, J. C., 46
Bradbury Well, 54, 103
Bradley and Ekstrom Incorporated, 53
Bradley, Walter, cited, 502, 506, 509, 511
Braito claims, 351
Braun, William, 57
Brentwood, 317, 562, 581, 584
Brentwood coal mine, 572
Brentwood deposit, 583
Briggs, Harry, 51, 78
Bright, T. L., 48
Brighton, 9, 10
Brisbane, 365
Bristol Lake, 276, 356
British American Oil Company, 322
Broken Ledge claim, 81
Bromine, 276
Brooks Island, 585
Brooks mine (see Little Shot), 90
Brooks perlite deposit, 104
Brown, 53, 85
Brown, George, 89
Brown, H. M., 74
Brown Monster (see Reward mine), 38, 48
Brown Monster-Reward (see Reward mine), 48
Brown Valley, 346
Bruce Canyon, 41
Brunswick unit, 347
Brush Creek mine, 371

Buckeye Creek, 382
Buckeye (see New Era) mine, 47
Buckhorn dry lake, 330
Buckner, L. H., 81
Buell Flat Rock Company, 367
Buena Vista Buttes, 312
Bugni, Peter, 583
Bulmer, Mrs. Laura, 104
Bunch Rock claim, 533
Burchard, E. F., cited, 44
Burchim, Jim, 74
Bureau of Water and Power, City of Los Angeles, 22
Burkhart, A. R., 507
Burns Creek, 339
Burrell, M. L., 368
Burrell area, 521
Burro claim, 39
Burton, Clifford G., 41, 49
Burton, H. Clifford, 41, 46, 49, 50
Burton, Nathan, 54
Burton Brothers Inc., 40, 41, 43, 46, 49, 280, 330
Bush, R. D., cited, 322, 380, 592
Butler and Dye, 325
Butte County, 311, 313-314; chromite, 277; gold, 279; mineral water, 282; natural gas, 282; platinum-group metals, 283; sand and gravel, 284; silver, 285; stone, 286
Butte Creek, 313, 314
Butte Creek Rock Company, 313
Butte Lode Mining Company, 330
Butte mine, 330
Buttes Oilfields, Inc., 380
Byles, 511
Byles, Ben J., 510
Byles, Joseph, 510
Byron Hot Springs, 576

C

C. and H. Materials Company, 330
Cache Creek, 387, 388
Cache Creek Sand and Gravel Company, 387
Cache Slough, 376
Cactus mine, 280
Cactus Queen mine, 330
Cajon Pass area, 356
Calaveras Cement Company, 311, 315, 527
Calaveras Central mine, 316
Calaveras County, 311, 312, 314-316, 362, 384, 597; cement, 277; clay, 277; copper, 278; gold, 279; lead, 281; mineral water, 282; pumice, 284; pumicite, 284; sand and gravel, 284; scoria, 284; silver, 285; zinc, 287
Calaveras formation, 338, 510
Calaveras limestone, 320
Calcium chloride, 276
Cal-Dri Ice Corporation, 339
Calearth clay deposit, 98, 327
Calearth Corporation, 98
Calearth deposit, 98; Nos. 1-4 claims, 98
Calera limestone, 367
Caliente claim, 45; No. 2 claim, 45
California Art Tile Corporation, 572
California Black Granite Company, 360
California claim, 59
California Electric Company, 130
California Electric Power Company, 22
California Industrial Materials Company, 336
California mine, 346, 498
California-Nevada Building Materials Producers pumice deposit, 107

California-Nevada Power Company, 94, 95
California Peat Company, 594
California Portland Cement Company, 333, 356, 358
California Pottery Company, 315
California Salt Company, 356
California Silver Corporation, 358
California State Division of Highways, 585
California State Division of Mines, 22, 273, 629
California State Division of Oil and Gas, 518, 522, 592
California State Lands Commission, 120
California Talc Company, 119
California Testing Laboratories, 54
California Water Service Corporation, 566
Camanche district, 312
Cambrian, 23, 100, 626, 634
Cambrian, Lower, 18
Cambrian, pre-, 18, 28, 39, 44, 123, 124, 126, 358, 632
Cameron mine, 350
Camp and Yates, 331
Campbell, R. E. estate, 88
Camp Dunmovin, 109
Camp Evers Junction, 368, 369
Cannon, Brigham T., 40
Cannon and Company, 353
Cantley, W. R., 98
Canyon Creek, 382
Canyon Dam, 351
Canyon Rock Company, 360
Capitol Dredging Company, 354
Capwell, A., 325
Carbonate (see New Sutherland Divide Mining Company) mine, 76
Carbonate King mine, 358
Carbon dioxide, natural, 277
Carboniferous, 531
Cardinal Gold Mining Company, 38, 39, 87
Cardox Western Inc., 326
Carey Creek, 498
Cargo Muchacho mine, 326
Carlson, Emil, 123
Carol, J. E., 103
Carpenter, Alvin B., 38, 39
Carquinez quadrangle, 577
Carquinez Strait, 318, 563, 564, 572
Carrizo formation, 325
Carroll, Frank, 39
Carson Pass, 310
Casa Diablo Hot Springs, 342, 343
Cashier (see Independent mine), 44, 46
Cashier Mining Company, 44
Cassidy, Arthur R., 83
Castro Point, 585
Caudell and Johnson, 360
Cave Canyon, 358
Cecil R mine, 40
Cedar Springs claim, 511
Cement, 277
Cenozoic, 19
Centennial mine, 316
Central Eureka Mining Company, 280
Central Rock and Sand Company, 322, 529
Central Sand and Gravel Company, 313
Central Valley, 486, 509
Central Valley Project, 566
Cerro Gordo Extension (see Royal group), 79
Cerro Gordo mine, 55, 58, 59, 70, 84, 328

Cerro Gordo Mines, 79
Chalco copper mine, 374
Chalfant, W. A., cited, 19, 60
Challenge claim, 78
Chambers, L. S., cited, 518
Champion Sillimanite Inc., 343
Chemung mine, 342, 343
Cheney Creek, 325
Cherokee mine, 313
Chester, D. B., 107
Chesterman, Charles W., 22, 103, 508, 579
Chestnut, Charles O., 130
Chiapella, S. E., 123
Chico formation, 572
Childers, W. H., 502
Childers feldspar deposit, 502
Chili Gulch, 316
China Lake, 131
China Ranch deposit, 128
China Stope area, 328
Chino Hills area, 356
Chloride Cliff mine, 84
Chollas Valley, 360
Chowchilla field, 335
Chowchilla River, 336, 339
Christmas Gift mine, 59, 328
Christmas Gift Mines, Incorporated, 59, 328
Chromite, 277
Chubbuck Lime Company, 356
Church, Dallas, 347
Churchill, C. W., 127
Ciervo anticline, 355
Ciervo Ridge, 490
Cinder Cone Mountain, 374
Claire, D. H., 47, 48
Claire, V. D., 47
Claire, W. D., 47
Clara H mine, 493
Clark Mountain, 358, 619, 625, 626, 629
Clark Mountain area, 630, 631
Clark Mountain coal bed, 583, 590
Clay, 277
Clear Creek, 370, 371
Clear Lake, 332
Clemens Granite Company, 360
Clement bridge, 362
Clement Gravel Company, 362
Clingan, William, 529, 532
Clingan's Store, 532, 533
Coal, 278
Coalinga anticline, 518
Coalinga district, 496
Coalinga East field, 486, 514, 517
Coalinga East Extension, 514, 518
Coalinga-Kettleman trend, 518
Coalinga Mineral Springs, 512
Coalinga Westside field, 517
Coast Range Oil Company, 514
Coast Ranges, 322, 485, 486, 488, 489, 490, 491, 497, 504, 506, 510, 514, 562, 563, 564, 571
Coarsegold Creek, 336
Coffee Creek, 382
Cole, Clyde, 341
Collins Springs, 512
Colluseum mine, 625

Colony placer mine, 371
Colorado claim, 75
Colorado group (see Zinc Hill mine), 82
Columbia mine (see Darwin Mines), 59, 60; No. 2 mine (see Shoshone Mines), 80
Columbia quarries, 384
Columbia Steel Company, 319, 583, 584
Colusa County, 317; sand and gravel, 284
Combination claim, 36, 37
Combination mine, 338
Combined Metals Reduction Company, 83
Comet Nos. 1-2 claims, 124
Comstock claim, 78
Concord quadrangle, 574
Confidence (see Confidence-Mendocino mine), 40
Confidence claim, 75
Confidence vein, 40
Conn Creek, 346
Connor Creek, 381
Conn Valley, 345
Conoco Company, 364
Consolidated Rock Products Company, 335
Consolidated Tungsten mine, 383
Contra Costa County, 317-319, 353, 376, 490, 500, 562, 563, 565, 566, 567, 572, 573, 574, 575, 576, 577, 581, 584, 588, 591, 592; clay, 277; mineral water, 282; natural gas, 282; peat, 282; sand and gravel, 284; stone, 286
Copper, 278
Copper Canyon, 128
Copper Hill mine, 311
Copper King, 498, 500, 501
Copper Queen Group No. 2 (see Gold Bottom mine), 70
Coral Reef Lime Products Company, 507
Corona claim, 40
Corona mine, 39, 40, 328
Corona Mining Company, 40
Corona Nos. 1-2 claims, 40, 41
Coronado Copper and Zinc Company, 370
Cortina Creek, 317
Corum, D. D., 39
Coso Basin, 131
Coso district, 85
Coso Hot Springs, 84, 85, 104
Coso Junction, 104, 107, 327
Coso Mountains, 18, 21, 23, 53, 83, 104, 106, 107, 110, 131
Coso perlite deposits, 104, 107
Coso quicksilver deposit, 85
Coso quicksilver district, 23
Cosumnes Gold Dredging Company, 354
Cosumnes mine, 321
Cosumnes River, 312, 353, 354
Cottonwood Canyon, 72
Covey, W. E., 352
Cowell Lime and Cement Company, 562, 567, 574, 581
Coy, O. C., cited, 487
Coyote Canyon, 45
Coyote Ridge, 29
Crabtree, E. H., 385
Cragco Products, Inc., 320
Crandall, Marion, 69
Crater group, 113
Crawford, G., 90
Crawford, J. J., cited, 36, 53
Crawford deposit (see Tungstar mine), 95
Craycroft Brick Company, 322, 496
Crescent Gold Dredging Company, 382
Crescent Mills, 350, 351

Crescent Pacific Mining Company, 279, 347, 371
Cress, J. C. estate, 50
Cretaceous, 363, 376, 485, 486, 490, 510, 511, 562, 564, 572, 591, 592
Cretaceous, pre-, 371, 506, 507, 508, 529, 531
Cretaceous, Upper, 380, 490, 491, 517, 521, 572
Cro-Diatomite Company, 379
Crooks and Ustick, 512
Crowder, C. L., 325
Crown claim, 49
Crystal and Black Granite Company, 360
Crystal Silica Company, 360
Crystal Springs formation, 123, 124, 125, 126
Cunningham, Mr., 594
Cuyama-Carrizo region, 363
Cuyama field, South, 363, 365 ; North, 363
Cuyama Valley, 363, 365
Cuyama Valley oil field, 273

D

Dahlberg, H. W., 9
Dale Chemical Industries, Incorporated, 356
Dale Lake, 356
Dalley (see Channel) mine, 314
Damon, A. L., 71, 77
Danziger, J. L., 97
Darwin antimony mine, 29
Darwin Consolidated Tungsten Corporation, 70
Darwin Development Company, 60
Darwin district, 19, 84, 85, 100
Darwin Hills, 28, 29, 100
Darwin Lead Company, 60
Darwin-Lead Silver Development Company, 60
Darwin lead-silver district, 23, 37
Darwin Mines, 55, 59, 64
Darwin Plateau, 21
Darwin Silver Company, 60
Darwin Wash, 68
Davenport mine, 41, 42
Davies, Ralph, 60
Davis, D. L., cited, 55, 59, 60, 68
Davis, F. F., cited, 482
Davis, James C., 36
Davis, R. E., cited, 527
Davis, Sam, 533
Davis, Walter, 69, 106
De Angelis Coal Company, American Lignite Products Company Division, 311
Death Valley, 18, 20, 21, 22, 23, 28, 83, 84, 100, 101, 104, 106, 123, 124, 128, 129, 130, 632
Death Valley borax deposits 128
Death Valley deposit 114
Death Valley gem onyx 101
Death Valley Junction, 20, 98, 99
Death Valley Materials Corporation pumice deposit, 107
Death Valley mica mines, 103
Death Valley National Monument, 20, 45, 52, 106
Death Valley onyx deposit, 101
Death Valley Talc Company mine, 123
De Carbonel, W., cited, 70
Deep Springs Valley, 86, 129
Deepwater Chemical Company, 334
Deer Creek, 372
Defense mine, 68, 328
Defiance (see Darwin Mines), 59, 60, 64
Degner, H. C., 101
Del Mexico mine (see Mexican mine), 511
Del Monte mine, 498

Del Monte Properties Company, 344
Delmontian, 386
Del Norte County, 51, 277, 319 ; chromite, 277 ; mercury, 281 ; sand and gravel, 284 ; stone, 286
Del Norte group, 43
Del Norte Mining Company, 43, 51
Delta claim, 75
Delta pumice mine, 342
De Sabla district, 313, 314
Desert Materials Company, 327
De Soto zone, 333
Detloff, Arthur, 104
Devil's Kitchen area, 85
Devonian, 58, 69, 100, 101
Diablo Pumibloc Company, 579
Diablo Range, 485, 486, 489, 490, 491, 564
Diamond Mountain, 332
Diamond Springs Lime Corporation, 320
Dibblee sand, 365
Dicalite Division, Great Lakes Carbon Corporation, 333, 366
Dickey Exploration Company, 372
Dietrich, W. F., cited, 496
Dillon Creek, 375
Dillon, E., 315
Diltz-Oro Grande mine, 338
Dinkey Creek, 532
Division Creek, 87
Division Creek tungsten mine, 87
Dog Creek, 500
Dolomite, 327
Dolomite Products, Inc., 101, 102, 327
Domengine formation, 521, 562, 590
Dominguez field, 334
Dominguez mine, 338
Donahue, Mr., 75
Donna Loy group, 124
Donner mine, 316
Douglass No. 1 claim, 631
Douglass No. 2 claim, 629, 631
Dow Chemical Company, 334
Downey, M. G., cited, 480
Drabble mine, 498
Drake, H. E., 507
Drake Lime Company, 507
Draper and Adams, 380
Driver mine (see Darwin Mines), 59
Droubay, S. K., 59, 80
Dry Creek, 312, 313, 331
Dub, George D., cited, 129
Dublin Hills, 106
Dunlap Ranch, 323
Dunlap-Squaw Valley road, 511
Dunn, 80, 109, 127
Dunn, D. H., 101
Dupuy, Leon W., cited, 85
Durham (see Fernando and St. Charles group), 70
Dutch Flat, 350
Dyer, E. H., 9, 10

E

Eagle Mountain mine, 280
Eagle Mountains, 351
Eagle Peak, 573
Eagle Roost Point, 369

Earlonite Mining Company, 526
East Bay Municipal Utilities District, 566
East Belt, 310, 312, 315, 337, 338
East End mine (see Bob Cat claims), 114, 117
Eastman placer, 347
Eckel, Edwin, cited, 511
Eckloff, W. L., 70
Eclipse group, 48
Eclipse mine, 114, 124; Nos. 1 to 2 claims, 124, 125
Edwin claim, 52
Eel River, 324, 325
Ehron, Liston, 381
Einstein, E. M., 498
El Camino Viejo, 487
El Diablo mill, 87, 91, 329
El Diablo Mining Company, 90, 94
El Dorado County, 319-321, 482; gold, 279; lime, 281; sand and gravel, 284; silver, 285; slate, 286; soapstone, 287; stone, 286
El Dorado Limestone Company, 320
El Dorado Rock and Sand Company, 320
Eleanor mine, 114, 117
Elliott, N. James, 56
Ellison Bros., 507
El Paso Mountains, 632
El Portal deposit, 337, 338
El Rio Rock Company, 386
El Toro Clay Company, 348
Emigrant Canyon, 51, 52, 53
Emigrant Springs, 43, 45
Emily May (see JDG marble claims), 102
Empire claim, 49
Empire mine, 346, 591
Empire Star Mines Company, Ltd., 280, 346
Empress mine, 69, 328
Enterprise Mining Corporation, 328
Entremont, Paul, 317
Eocene, 317, 319, 321, 329, 331, 335, 376, 498, 521, 522, 562, 581, 584, 590, 592; middle, 581; upper, 521
Eocene production, 514
Eocene sands, 521
Eric, J., cited, 500
Erickson, Elmer, 336
Erickson, Max P., cited, 85, 86
Erie mine, 347
Escarpado Canyon, 490
Essex (see Darwin Mines), 59, 324
Estelle and Morning Star Mines, 69
Estelle Mining Corporation, 69
Estiel, C. S., 504
Etchegoin, 517
Etna quicksilver mine, 346
Eureka claim, 78
Eureka Sand and Gravel Company, 324
Eureka Slough, 323, 324
Eureka Valley, 19, 114, 118
Evans, Frank, 331
Evans, H. R., 49
Evans, Kennett, 331
Evans, M. Harrison, cited, 62, 72
Everett, Ben J., 530
Ewart, J. D., 87
Exposed Treasure (Standard Hills Mines Company) mine, 330

F

Fairbanks, Harold W., cited, 22
Fairbanks, L. D., 124
Fairview Placers, 381
Fairway Placers, 279
Farmington mine, 385
Farnsworth hydraulic mine, 374
Favret, Louis, 632
Feather River, 313, 314
Feather River Rock Products Company, 313
Federal Production and Marketing Administration, 505, 506
Feldspar, 278
Felton quarry, 369
Fennamin, Jack, 321
Fenton, H. A., Material Company, 360
Ferguson (see Sample mine), 510
Fernando (see Fernando and St. Charles group), 70
Fernando and St. Charles group, 70
Ferndale Springs, 576
Ferro group, 53
Ferro-Titan Minerals Company, 335
Feuerstein, Al, 322, 508, 534
Filmer, Coy, 576
Finley, Ross, 75
Finley Company, 80
Fish Creek Mountains, 326
Fish Springs, 104, 105, 327
Fish Springs district, 47
Fish Springs perlite deposit, 105
Fitzgerald, E. F., 77
Fleishhacker Zoo, 361
Fletcher, C. W., 70
Flint, B. C., cited, 45
Florence mine (see White Mountain claims), 121, 122
Florence property, 114
Florence reservoir, 488
Fluorite Numbers 1-2, 632
Fluorspar deposit, 632
Fluorspar group, 619
Foothill Belt, 310, 312, 315, 316, 498
Ford, Kirby, 339
Ford mines, 385
Foreman, L. D., 68, 69, 328
Foreman and Company, 76
Fort Miller Ranch deposit, 526
Foss, A. L., 81, 82
Foster, L. E., 341
Fox, R. E., 577
Fox Water Company, 577
Frame, R. G., cited, 376, 521, 591
Franciscan formation, 318, 361, 362, 490, 491, 510, 562, 564, 585
Franciscan, post-, 491
Franciscan, pre-, 564
Franciscan sandstone, 319, 337, 365, 564, 573, 575, 576, 585, 586
Franklin, Mason E., 73
Fraser, H. J., cited, 85
Frederickson Brothers, 345
Free Thinker, 637
Freitas, John and Son, 339
Fremont, Captain John C., 19
French Gulch Dredging Company, 374
Fresno Copper Company mine, 501, 502
Fresno County, 19, 273, 321-323, 485, 486, 487, 489, 490, 491, 492, 493, 496, 497, 500, 501, 503, 504, 505, 506, 509, 510, 512, 514, 520, 521, 522, 525, 528, 531, 600, 602; clay, 277; gypsum, 280; mercury, 281; natural gas, 282; natural gas liquids, 283;

oil and gas reserves, 516; petroleum, 283; sand and gravel, 284; silver, 285; stone, 286; tungsten, 287
Fresno Hot Springs, 512
Fresno Irrigation District, 526
Fresno magnesite mine, 510
Fresno pumicite, 527
Fresno River, 336, 487
Fresno Slough, 487
Frey, H. W., 108
Frey, M., 105
Friant Dam, 322, 323, 486, 503, 526, 527, 528
Friant formation, 527
Frisco mine, 114, 117
Fuller, F. J., 312
Funeral Mountains, 38, 84
Furnace Creek, 21, 29, 95, 100, 101, 128

G

Gabilan Range, 354
Gable Creek, 89, 95
Gale, H. S., cited, 22, 23, 129
Galena Canyon, 123
Gallagher, Frank E., 338
Galloway, John, cited, 520
Gallup, B. E., cited, 478
Gard, A. D., 87
Gardner mine, 321
Garnet Dike, 532; mine, 531, 532, 533
Garnet Hill mine, 316
Garvell, Mrs. L. B., 634
Gatchell area, 518
Gatchell sand, 518
Gem (see Corona mine), 40
Gem stones, 278
General Chemical Division plant, 603
General Dredging Company, 354, 511
Genii mine, 314
Gerbracht, Della, 632
Gianelli, Al, 315
Giant King (see Washington Creek) mine, 347
Gibralter (see Honolulu-Big Horn mine), 72
Gibson, Marshal, 587
Gibson and Keenan, 385
Geig, F., 578
Gilbert, C. M., cited, 110
Gill Ranch field, 335
Gilroy, 367
Gilzean, J. A., 381
Gilzean, W. M., 381
Ginochio, L., 581, 583
Gladding, McBean and Company, 311, 348, 349, 351, 357, 380, 572, 604
Glassbrook, R. L., 40
Glass Mountain, 373, 374
Glass Mountain Brick Company, 341
Glass Mountain Volcolite Company, 341
Glen Ellen, 377
Glenn County, 323; natural gas, 282; sand and gravel, 284
Globe mine, 381
Glorietta anticline, 591
Gobert, Pete, 39
Godon, Jean, 317
Goff claim, 52
Goforth Brothers, 317
Gohegan, Harold E., 102
Gold Belt group, 332

Gold Belt mine, 637
Gold Bluff mine, 371
Gold Bottom mine, 70; Mines, Inc., 71, 77
Gold Bug (see Knob group), 45
Gold Hill (see Panamint Treasure mine), 43, 47, 79
Gold Hill Dredging Company, 73, 314, 328, 362
Gold Point mine, 371
Gold Queen mill, 48; Mining Company, 48, 58
Gold Spur (see Lestro Mountain mine), 45
Gold Treasure (see Ashford) mine, 39
Golden Eagle group, 43
Golden Gate Bridge, 527
Golden Star mine, 371, 385
Golden West quarry, 365
Goldfield Consolidated Mines Company, 347, 381
Goldstone, L. P., cited, 498, 502
Goler Canyon, 45, 46, 330
Goodale Creek, 87
Good Gulch mine, 338
Good Hope Nos. 1 to 2 claims, 83
Goodsprings dolomite, 627
Goodwin, Frank B. and Son, 387
Goodyear, W. A., cited, 22, 590
Gower, Harry, 105, 106, 125
Graham-Jones (see Ruth mine), 49
Grand View claims, 71
Granite Rock Company, 355
Grant and Grant Engineering Company, 366
Grant mine (see Shoshone Mines), 80
Grantham, Miss Louise, 43, 47, 79, 126, 127, 327
Grant-Pacific Rock Company, 503, 529
Grant-Service Rock Company, 503, 529
Grapevine Canyon, 106
Grass Valley-Nevada City district, 280
Gravellite Company, 481
Gray, W. Howard, 51
Grayson, Harold, 332
Grayson and Spurgeon quarry, 332
Grayson Cement Materials Company, 332
Great Eastern prospect, 377
Great Falls, Montana, 68, 370
Great Lakes Carbon Corporation, 333
Great Valley of California, 488, 490, 491, 564
Great Valley range, 489
Greenauger, Gordon, 337
Green, Gayle, 88
Green Hornet, 619, 634
Greene, Charles A., 95
Greenland Ranch, 21, 22
Greenstone Canyon, 533
Greenwater district, 37
Greenwood Creeks, 321
Greenwood, Myrtle, 78
Greenwood, William, 78
Griest, George, 56
Griffin deposit, 505
Griffith Company, 323, 503, 528
Grimshaw, Ed., 106
Grimsley, G. P., cited, 574
Griswold Canyon, 355
Grizzly Flats, 321
Grizzly mine, 385
Grizzly Spring, 331, 332
Groah Mineral Company, 119
Groover, F. E., 29

Guadalupe mine, 368
Guijarral Hills, 321, 490
Guijarral Hills oil field, 518
Gulch group (see B and B Sulphur Company), 113
Gunn, Mrs. Jack, 75
Gunsight mine (see Shoshone Mines), 55, 80
Gunter Canyon, 98
Gurnn, G. R., cited, 480, 482
Gypsum, 280

H

Hageman, Harry, 82
Hageman, Percy, 53
Hague, Edward, 40
Haiwee Reservoir, 108, 110, 327
Halbert, J. C., 340
Hall Canyon, 44
Hallwood gravel plant, 388
Hamberg, Fred, 371
Hamilton City, 323
Hancock Oil Company, 363
Hanging Valley mine, 88
Hanging Valley Mining Corporation, 88
Hanner Mining Company, 337
Hanson-Silvey-Sinnott quarry, 369
Harms Brothers, 376
Harper deposit, 510
Harrington, C. H., 106
Harris, M. L., 332
Harrison-Birdwell, 586; quarry, 318
Harrison Stock Farm, 502
Hart Mining Company, 500
Hartley, Gerald B., Jr., 95
Haydite, 336, 337
Hayes, J. P., 352
Hayward (see Fernando and St. Charles group), 70
Hazel-Atlas Glass Company of California, Ltd., 583
Hazel Creek mine, 321
Hazzard, John C., cited, 23, 100
Hearst claim, 75
Hecker Pass, 367
Hector mine, 357
Heikes, V. C., cited, 574
Hein, J. H., Company, 370
Hein Bros. Basalt Rock Company, 377
Heiskell Extension, 501
Helm field, 514, 521, 522
Hemlock claim, 78
Henderson, Frank, 117
Henderson, Nevada, 356
Henry, James H., 339
Herbert, O. A., 382
Herndon Rock Products, 503, 530
Heron, Charles M., 71, 72
Hetch Hetchy aqueduct, 385
Hewett, D. F., cited, 627
Hewitt, R. L., cited, 489, 491
Hidden Treasure group, 48
Hidden Treasure mine, 385
High Grade claim, 126
High Grade district, 340, 341
High Grade mine, 355
High Silver claim, 78
Hill Brothers Chemical Company, 356
Hillman, D. H., 103

Hilton, C. L., 533
Hindley Clay Products Company, 324
Hines, Louis, 82
Hirsh group, 48
Hoerner, Mrs. Oscar L., 637
Hog Mountain region, 493
Holcomb, Sam L., 69
Holloway, H. M., 331
Holloway, H. M., Incorporated, 330
Holly Sugar Corporation, 15
Holmes, Dale, 352
Holmes, T. W., 94
Holmestake Mining Company, 325, 326
Homeward Canyon, 49
Homewood Canyon, 41
Homewood Mining Company, 46
Honolulu-Big Horn mine, 72
Hoot Owl (see Iron Cap deposit), 53
Hoover, William H., 59, 80
Honker Bay, 376
Hope group, 57
Hopkins, H. H., 503
Hopkins, Paul, 38
Hopkins-Becker Dredging Company, 503
Hopper, Richard H., cited, 23, 28
Hornet mine, 284, 370
Hornspoon mine, 44
Horton Lake, 88
Hot Springs Canyon, 512
Houghton, E. C., 532 ; J. B., 532 ; R. J., 532
Houk, L. G., cited, 480, 481
Houston mine, 374
Hove, W. C., 47
Hubbard Molding Sand Company, 360
Hub mine, 371
Huckleberry Canyon, 89
Hudson River claim, 78
Huffman, Orval, 37
Hughes, C. L., 79
Hughes group (see Lead mine), 73
Huguenin, Emile, cited, 22, 37, 72, 84, 128, 129
Huitt, H. H., 597
Humboldt County, 323-325 ; clay, 277 ; gold, 279 ; natural gas, 282 ; sand and gravel, 284 ; silver, 285 ; stone, 286
Hunt, T. C., 320
Hunter Valley, 337
Hunter Valley district, 280
Hunting, E. H., 634
Huntington reservoirs, 488
Huntley, W. H., 88, 127
Huntley, Wright, 121
Huntley Industrial Minerals, Inc., 88, 99, 100, 127, 343
Hutchinson Company, 337

I

Ibex Hills, 114, 125
Ibex mine, 357
Ibex Pass, 20
Ibex Springs, 357
Idaho Maryland Mines Corporation, 280, 346
Ignacio (see Cerro Gordo mine), 58
Ida claim, 78
Illinois-Kentucky, 621

Imperial County, 325-326, 482; carbon dioxide gas, natural, 277; gold, 279; gypsum, 280; mica, 281; pumice, 284; pumicite, 284; sand and gravel, 284; scoria, 284; silver, 285; stone, 286
Imperial Smelting and Refining Company, 60
Independence claim, 78
Independence mine (see Darwin Mines), 59, 60
Independence-Thompson group, 64
Independent mine, 44, 46
Independent Rock Company, 386
Indian Wells Valley, 23, 131
Industrial Mineral Sales Company, 583
Industrial Minerals and Chemical Company, 502
Inerto Company, 357
Inglewood field, 334
Ingram, Stuart H., cited, 480
Insulating Aggregates Company, 342
International Smelting and Refining Company, 80, 83, 91, 358
Inyo County, 18, 19, 20, 21, 23, 28, 37, 38, 53, 55, 83, 84, 85, 98, 99, 100, 101, 103, 104, 106, 112, 113, 114, 128, 129, 130, 131, 273, 326-329, 330, 343, 347, 482, 486; antimony, 276; asbestos, 276; boron minerals, 276; clay, 277; copper, 278; diatomite, 278; feldspar, 278; gold, 279; lead, 280, 281; molybdenum, 282; perlite, 282; pumice, 284; pumicite, 284; pyrophyllite, 287; sand and gravel, 284; silver, 285; slate, 286; soda, 286; sulfur, 286; talc, 287; tungsten, 287; zinc, 287
Inyo Development Company, 129
Inyo Marble Company, 100, 101, 327
Inyo Mountains, 18, 19, 20, 21, 22, 23, 28, 48, 58, 69, 79, 83, 84, 89, 96, 98, 100, 108, 109, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 127
Inyo Pumice Corporation deposit, 108
Inyo Range, 326, 327
Inyo Talc Company mine (see Talc City mine), 119
Iodine, 280
Ione clay, 314
Ione district, 310
Ione formation, 315, 384, 490
Ione sand, 311
Irelan, William, Jr., cited, 507, 575
Irish, Mrs. Eva, 118
Irish lease, 118
Irish mine, 114
Iron Cap deposit, 53
Iron Chief group, 53
Iron Mountain, 370
Iron ore, 280
Irons, Kenneth, 89, 90
Irvine Salt Company, 348
Island claim, 49
Ivanpah Mountains, 358, 634
Ivanpah Mountains deposit, 634
Ivanpah quadrangle, 625, 627

J

Jacalitos oil field, 518
Jacalitos ridge, 490
Jack Pot mine, 534
Jack Rabbit mine, 88
Jackson Creek, 312
Jackson, M. C., 316
Jacques, Wm., cited, 526
Jail Canyon, 39, 40, 41
J and M group (see Hanging Valley mine), 88
James Creek, 324
James, C. W., 77, 122
Jamieson, Alexander, 108
Jamieson pumice deposit, 108
Jarvis, Henry B., 111, 112

Jawbone Canyon, 330
JDG marble claims, 102
Jenkins, Olaf P., cited, 20, 23, 78, 489, 491, 510, 564, 575
Jensen, N. C., cited, 480
Jensen quarries, 351
Jergins Company, 364
Jergins No. 1, 490
Joaquin claim, 511
Johanson, H. O., 94
Johns-Manville Products Corporation, Celite Division, 366
Johnson, B. L., cited, 482
Johnson, Buck, 44
Johnson, C. F., 86
Johnson, Emil and Sons, 360
Johnson, John, 315
Johnson's Mill, 320
Johnson, S. W., 83
Johnson, W. H., and Company, 357
Jones, H. A., 334
Jones Creek, 375
Jordan, R. L., 36
Journigan, Roy, 43, 45, 51, 52
Journigan's custom mill, 43, 45, 53
Juarez quarry, 346
Jumbo mine, 89
Juniper mine, 355
Jurassic, 28, 318, 385, 500, 562, 564, 573, 575, 634; Upper, 23

K

Kaiser, Henry J., Company, 313, 317, 368, 580, 587
Kaiser Aluminum and Chemical Corporation, 344
Kaiser Steel Corporation, 352
Kate Hardy mine, 371
Kaweah River, 383
Keane Wonder mine, 38
Keck, Marie, 57
Keeler Gold Mines Incorporated, 70
Kelley and McWhorter Sand and Gravel Company, 324
Kelley Hill mine, 314
Kelley, Vincent C., cited, 23, 28, 60, 70, 81
Kelley mine, 381, 385
Kelsey Creek, 331, 332
Kelso, Robert W., 91
Kempe, Allan, 71, 72
Kennedy, F. A., 315
Kennedy, J. J., 125, 313
Kennedy claim, 36, 37
Kennedy Eclipse (see Eclipse mine), 124
Kennedy Minerals Company, 125, 126, 127, 327
Kentucky Hill mine, 338
Kerdell lead mine, 72, 328
Kern County, 20, 28, 131, 273, 329-330, 383, 387, 492, 514, 527; antimony, 276; boron minerals, 276; cement, 277; clay, 277; feldspar, 278; gold, 279; gypsum, 280; natural gas, 282; natural gas liquids, 283; petroleum, 283; salt, 284; sand and gravel, 284; silica, 285; silver, 285; stone, 286; tungsten, 287
Kern Lake, 330
Kern River, 330
Kerr, Leroy, 387
Kettleman Hills, 518
Kettleman Hills oil field, 331, 600
Kettleman North Dome, 486, 514, 516, 520
Kettleman Ridge, 490
Key, T. W., 87
Keyes claim, 75
Keystone mine, 371

King, Clarence R., cited, 130
Kings County, 273, 331, 486, 516, 520, 600; gypsum, 280; natural gas, 282; natural gas liquids, 283; petroleum, 283; sand and gravel, 284
Kings River, 321, 322, 486, 487, 490, 507, 508, 509, 510, 528, 529, 532, 533
Kings River mines, 533
Kingston Mountains, 357
Kingston Range, 114
Kirby, A. G., 60
Kirby Hill gas field, 376
Kirk and Stokesbury, 368
Kirk, Edwin, cited, 21, 22, 23
Kirkpatrick mine, 371
Kisk estate, 45
Kitching, R. E., 113
Kittle, Otis A., 95
Kittle Mining and Exploration Company, 94, 329
Klamath River, 325, 375
Klondyke mine, 341
Knapp, Milton L., 95
Knob group, 45; Nos. 1 and 2 claims, 45
Knopf, Adolph, cited, 21, 22, 23, 38, 48, 58
Knotts, C. F., 53
Knudsen, Edward T., cited, 514
Koehler, S. H., 39
Koest, George, 116, 119, 120, 121
Kokoweef Mountain, 358
Korfist No. 1 claim, 629, 631
Koski group, 511
Koski, J. M., 511
Kramer deposits, 128
Kreyenhagen Hills-Kettleman North Dome area, 490
Kreyenhagen ridge, 490
Kreyenhagen shale, 514

L

Lacey mine, 493
La Cienega district, 354
Ladoo, R. B., cited, 621, 623
La Grange Gold Dredging Company, 379
Lagunitas Creek, 336, 337
Laizure, C. McK., cited, 502, 512, 567, 571, 575, 576
La Jolla Canyon Clay Products Company, 360
Lake County, 281, 331-332; mercury, 281; mineral water, 282
Lake Superior, 622
Lakeview claim, 98
Lakeview mine, 114, 118, 343
Lakeview talc deposit, 118
Lakeview tungsten mine, 89
Lambert mine, 313
Lambert, Stanley, 89
Lambert tungsten mine, 89
Lanare area, 521
Lancha Plana Gold Dredging Company, 280, 314, 354
Lane and Nikolaus (see Nikalous talc mine), 118
Lane's Bridge, 335, 503, 528
Lang Brothers, 332
Largo Plant, 335
Larmour, H., McC., cited, 526
Larry Jean claim, 49
Lassen County, 332-333; sand and gravel, 284
Last Chance Canyon deposit, 632
Last Chance Range, 21, 112, 113
Lauterwasser Creek, 591
Lawlor tuff, 577, 578
Lawson, A. C., cited, 564, 574, 575, 587

Laylander, King C., 131
Lea, F. M., cited, 527
Lead, 280
Leadfield district, 55
Lead King (see Lippincott lead mine), 73
Lead Queen claim, 79
Lea-Grant mine, 355
Leavitt, C. C., 500
LeCyr iron deposit, 54
LeCyr, J. R., 54, 79
Leda sand, 518
Leda zone, 321
Lee, Fred R., 88
Lee, John F., 40
Lee's Flat Road, 102
Lemmon, Dwight M., cited, 23, 89, 96
Lenbeck mine, 114
Lenhart, Walter B., cited, 86, 96
Lester, Mrs., J. H., 45
Lestro claim, 45
Lestro Mountain mine, 45
Leviathan mine, 310
Liberty group (see Darwin mines), 59
Liberty mine, 371
Lime Ridge, 562, 567, 570, 574
Lincoln Clay Products Company, 349, 362
Lippincott, George, 73, 74
Lippincott Lead Company, 73, 74, 328, 348
Lippincott lead mine, 73, 328
Liston Brick Company, 348
Lithium minerals, 281
Little, E. W. and Sons, 374
Little, J., 580
Little Antelope Valley, 343
Little Chief claim, 78
Little Dry Creek, 530
Little Maria Mountains, 352, 633
Little Panoche placer, 506
Little Sister mine, 88, 90
Live Oak mine, 364
Live Oak Mining Company, 361
Livermore Valley, 309, 563
Lockhart, Edith, 116, 119, 120, 121
Lockhart, L. M., 321
Lockwood, C. H., 52
Logan, C. A., cited, 100, 101, 504, 506, 574
Logtown Ridge formation, 385
Loit, George E., 59
Loma Blanca Mines, Inc., 369
Londsburg, A. P., 347
Lone mine (see Darwin Mines), 59, 60
Lone Pine, 20, 38, 118, 130
Lonesome Pine mine, 338
Long Beach field, 333
Longfellow mine, 385
Longley, F. S., 109
Lookout claim, 75
Lookout mine, 88
Lord, C. H., 60
Lord and Bishop, 321
Los Angeles Basin, 280, 514
Los Angeles Brick and Clay Products Company, 351

Los Angeles County, 273, 333-335, 482, 492, 514; cement, 277; clay, 277; diatomite, 278; Flood Control, 527; gold, 279; iodine, 280; mineral water, 282; natural gas, 282; natural gas liquids, 283; petroleum, 283; sand and gravel, 284; silver, 285; soapstone, 287; stone, 286; titanium, 287
Los Angeles Department of Water and Power, 112, 130, 131
Los Angeles Metropolitan Water District, 356
Los Angeles mine, 352
Los Angeles Pressed Brick Company, 572
Los Angeles Rattler Test, 585
Los Banos Gravel Company, 339
Los Gatos Creek, 367
Los Medanos Hills, 577, 578
Los Penasquitos River, 360
Los Positos Road, 367
Lotus mine, 45; Mines Inc., 45, 46
Loustalot, Rene, 40
Lower Comanche dredge, 362
Lucerne Valley, 357
Lucky Clover mine, 533
Lucky Day, 633
Lucky Jim mine (see Darwin Mines), 59, 60
Lucky Strike mine, 385
Ludikins property, 312
Lund, G. E., Jr., 89
Lynton, Edward D., cited, 112, 113

Mc

McAdam Creek, 374
McAfee, George A., 632
McAfee, L. L., 87
McAllister, James F., cited, 73, 74
McAllister, Wallace C., 529
McBroom, E. A., 374
McCord, J. T., 53
McCulley, J. W. E., 36, 69
McCullough, J. L., 87
McCullough, W. G., 580
McDonald Island field, 361
McDow, George Jr., 332
McEntyre, Ward, 74
McGill Rock and Sand Company, 346
McGirk, L. S., 54; Jr., 54
McIntosh, Alice H., 38
McIntosh, D. T., 323
McKenzie, A. H., 526; estate, 527
McKesson Bros., 317
McKinley, H. L., 94
McKinney deposit, 637
McLure, A. C., estate, 36
McMasters, E. L., cited, 526
McNall Building Materials Company, 365
McNear, L. P., Brick Company, 336
McPhee, D. G., cited, 602

M

Mabel mine (see Shoshone Mines), 80
Macal Construction Company, 580
MacArthur, J. S., 501
Macco Construction Company, 330
Macdonald, A., 501
Macdonald, G. A., cited, 489, 527
Mackevett, E. M., cited, 37
Madera County, 335-336, 486, 487, 500, 503, 504, 510; feldspar, 278; gold, 279; natural gas, 282; pumice, 284; pumicite, 284; sand and gravel, 284; silver, 285; tungsten, 287

Madison, J. P., 76, 77
Mad River, 324, 325
Mad River Sand and Gravel Company, 324
Madsen, Lester G., 323
Magalia district, 313, 314
Magna No. 1, 637
Magnesite, 281
Magnesium compounds, 281
Malone mine, 338
Manganese ore, 281
Manganite group, 83
Major, R. E., 73
Manoch, Foster, 78
Mansfield, G. R., 129
Marble Canyon, 38, 102
Marble mine, 90
Marble Springs mine, 338
Marchio Sand Company, 581
Mare Island quadrangle, 577
Margraf, Andreas, 9
Marhman mine, 385
Marin County, 336-337; clay, 277; mineral water, 282; sand and gravel, 284; stone, 286
Marin Gravel Company, 337
Marine Magnesium Products Corporation, 364
Mariposa Commercial and Mining Company, 338
Mariposa County, 337-339, 384, 487, 531; barite, 276; copper, 278; gold, 279; platinum-group metals, 283; sand and gravel, 284; silver, 285; slate, 286
Mariposa mine, 338
Mariposa slate, 320, 321
Markley deposits, 125
Marlife Company, 507
Marlifertilizer Company, 322
Marshall and Miles Gravel Company, 349
Marshall, F. A., 585
Marvel claim, 56, 78
Mary F claim, 39
Mary Len mine, 350
Marysville Rock Products Company, 388
Mason, J. F., cited, 23, 28
Mathews, Ferrar, 111
Mathews Sand, Gravel, and Dirt Company, 313
Mathyas, F. C., cited, 498
Matt, H., 101, 102
Maxwell, R. E., 384
May, J. C., cited, 489, 491
Mazourka Canyon, 38, 117
Mears Creek, 369
Mellott, Frank, 347
Mendocino County, 339; carbon dioxide gas, natural, 277; sand and gravel, 284; stone, 286
Mendocino vein, 40
Mendota-Firebaugh area, 335
Mengel, Carl, 46
Merced County, 339-340, 486, 487; gold, 279; platinum-group metals, 283; sand and gravel, 284; silver, 285
Merced Dredging Company, 280
Merced River, 338, 339, 340
Merced Sand and Gravel Company, 340
Mercer-Frazer Company, 324
Mercey Hot Springs, 506, 507, 512
Mercey mine, 511
Mercury (quicksilver), 281
Mercy Hot Springs, 322
Merriam, C. W., cited, 58

Merritt, Alfred L., 371
Merritt, George, 58, 79
Mesozoic, 489
Mesquite thrust, 627
Metals Reserve Company, 29, 492
Merry Christmas (see St. George mine), 50
Meur, R. L., 632
Mexican (see Del Mexico), 511
Mexican Diggings mine, 338
Mexican mine, 74
Meyers, Mrs. Hedvig, 78
Meyson, Charles, 77
Mica, 281
Mica schist, 325
Midland fault, 592
Midland Trail, 20
Middle Dome, 331
Middle Park, 78
Middletons-Sequoia Rock Company, 383
Middle Yuba mine, 271
Mid-State Equipment and Dredging Company, 340
Mielenz, R. C., cited, 527
Millar, Robert, pit, 323
Millar and Maine Prairie, 376
Millen, C. W., 598
Miller, M. B., 120
Millerton Lake, 486, 526
Millerton Spring, 512
Millovich, Juno, 88
Millovich prospect (see Hanging Valley mine), 88
Mills, A. I., 39
Millspaugh iron deposit, 54
Milton, A. R., 312
Milton gravel plant, 311
Mine and Mill pit, 349
Mine Hill, 368
Mineral Materials Company, 357, 359
Mineral pigments (natural), 282
Mineral Point (see Black Canyon mine), 57
Mineral Products Manufacturing Company, 502
Mineral water, 282
Miner Ranch oil field, 591
Minietta mine, 75, 328
Minkler district, 507
Mint Canyon, 335
Miocene, 318, 321, 322, 334, 363, 365, 368, 386, 490, 514, 517, 518, 521, 527, 562, 585, 591; middle, 521; upper, 344
Mires and Garner, 382
Mision del Rio de los Santos Reyes, 487
Missing Link Fraction claim, 59
Mission Clay Products Company, 349
Mission district, 361
Mission of the River of the Holy Kings, 487
Mission mine, 352
Mission Valley, 360
Mister mine, 54
Mittendorf, C. O., 45
Modelo shale, 334
Modoc claim, 75
Modoc County, 340-341; gold, 279; peat, 282; pumice, 284; pumicite, 284; sand and gravel, 284; scoria, 284; silver, 285
Modoc district, 19, 55
Modoc mine, 73, 75
Modoc Peat Moss Company, 340
Mohawk mine, 46, 358

Mojave Corporation, 329
Mojave district, 280, 329
Mokelumne gravel pit, 362
Mokelumne River, 316, 362
Molybdenum, 282
Molybdenum Canyon, 533
Molybdenum Corporation of America, 97, 98, 358
Monarch claim, 36, 37
Monarch Iron Consolidated Mines (see Iron Cap deposit), 53
Monarch mine, 357, 371
Mono County, 19, 20, 96, 109, 110, 127, 128, 329, 342-343, 486; copper, 278; gold, 279; lead, 281; pyrophyllite, 287; sand and gravel, 284; scoria, 284; silver, 285; stone, 286; tungsten, 287
Mono Lake, 342
Monolith Portland Cement Company, 329, 387
Monolith tuff, 527
Monopoly claim, 36, 37
Montalvo Rock Company, 386
Monte Cristo mines (see Lotus mine), 45, 46
Monterey Bay, 344
Monterey County, 10, 15, 273, 343-345, 482, 497; copper, 278; gem stones, 278; gold, 279; lead, 281; lime, 281; magnesium compounds, 281; natural gas, 282; petroleum, 283; salt, 284; sand and gravel, 284; silica, 285; silver, 285; stone, 286
Monterey group, 562, 573, 574, 585
Monterey series, 591
Montford marl deposit, 508
Montgomery, Owen, 632
Montgomery deposit, 114
Montgomery Pass, 20
Montgomery talc mine, 125
Moody, Frank, 335
Moonlight mine, 341
Moon, R., 493
Moore, H. C., 637
Moraga formation, 317, 562, 574, 585, 587
Morales Canyon, 363
Moreno, 517
Mormon (see Cerro Gordo mine), 58
Morning Star and Estelle Mines, 69, 70
Morris, 580
Morris, Ben, 580
Morris Ravine, 313
Morris Ravine Mining Company, 314
Morrison, Lafayette, 111
Mosbarger, G. O., 103
Mosher, Sam, 60
Mossina, Lawrence, 572
Mother Green's Ball Mountain Mineral Springs, 513
Mother Lode, 312, 337, 338, 339, 384, 385; district, 280, 310, 314, 315, 316
Mount Bullion, 337, 339
Mount Campbell, 506; district, 506; Lime Company, 508
Mount Diablo, 562, 563, 564, 566, 567, 573, 574, 575, 591; anticline, 564; area, 562, 567, 575; field, 590; Lime Marl Company, 574; mine, 575; Quicksilver Company, Ltd., 575; quicksilver mine, 563
Mount Gaines mine, 280, 338
Mount Gaines Mining Company, 280
Mount George, 345
Mount Goddard quadrangle, 21
Mount Jackson-Great Eastern quicksilver mine, 377
Mount Jackson mine, 377
Mount Jackson prospect, 377
Mount Morgan, 86
Mount Shasta, 373; Sand and Gravel Company, 374
Mount Tom, 95; mine (see Tungstar mine), 95
Mount Whitney, 18, 20, 21; quadrangle, 21; Talc Company, 120

Mount Zion, 573 ; mine, 571, 573
Mountain Copper Company, Ltd., 370, 603
Mountain Gold Dredging Company, 354
Mountain Pass, 357
Moyer Gravel Company, 341
Mugwump placer mine, 372
Munger, Ralph, 317
Munsinger, Mrs., 29
Murchio, G., 586
Murdoch, Joseph, cited, 28, 98, 100, 493, 567
Muroc Lake, 329
Murphy, F. M., cited, 23, 44, 47, 48, 56, 72, 78
Murray, Harry, 347
Murray Canyon, 360
Musgrove, C. L., 332
Myers, W. B., cited, 511
Myrick, E. L., 341

N

Napa County, 345-346, 361, 362 ; mercury, 281 ; mineral water, 282 ; perlite, 283 ; sand and gravel, 284 ; stone, 286
Napoleon group, 46
National claim, 52
National Lead Company, 338
National Perlite Company, 345
National Silica Company, 366
Natomas Company, 279, 353
Natural gas, 282
Natural Gas Corporation, 335
Natural gas liquids, 282
Natural Soda Products Company, 130 ; plant, 130
Nebicite feldspar-Kaolin deposit, 99
Neiper mine, 500
Nelson, J. B., 326
Nelson, J. M., 377 ; quarry, 376
Nelson and Sloan, 360
Ness, Silas, 57
Netherton, L. E., 53
Nevada County, 273, 346-347 ; gold, 279 ; lead, 281 ; sand and gravel, 284 ; silver, 285
Nevada-Massachusetts Company, 87
Nevada perlite, 598
Never Rest (see New Era mine), 47
New Almaden mine, 368
New Champion Mining Company, 316
New Discovery (see Corona mine), 40
New Enterprise (see Cerro Gordo mine), 58
New Era mine, 47
New Idria mine, 355, 511
Newman, J. W., 99
Newport Bay, 347, 348
New Sutherland Divide Mining Company, 76
New Trail mine, 358
Nicholls, A. E., 124
Nielsen Sand and Gravel Company, 316
Nikolaus, James, 118
Nikolaus mine, 114
Nikolaus talc mine, 118
Niles alluvial cone, 309
Nipton deposit, 637
Noble, L. F., cited, 22, 28, 39, 129
Noble's Camp (see Round Valley) mine, 94
Noble (see Round Valley) mine, 94
Noonday mine (see Shoshone Mines), 55, 80
Nopah group, 76
Nopah Range, 76, 124

North Dome, 331
North Star mine, 346, 355
Nortonville, 319, 583 (see Black Diamond) 590
Nortonville formation, 521
Nortonville Ranch, 571
Nortonville-Somersville, 581
Northwestern Mining Company, 375
Northwest Syndicate, 322
Nugget placer, 382
Nurse, R. W., cited, 527
Nuss, Claude, 530
Nutmeg mine, 338

O

O'Connor, W. C., 352
O'Connor, W. P., 352
O'Donnell, John, 371
Oakeshott, Gordon B., cited, 482
Oaks Sand, Gravel and Cement Products Company, 370
Oasis pumice deposit, 109
Oil City, 490, 514; area, 517; field, 517
Olancha quadrangle, 21
Old Bishop Tungsten mines, 87
Old Dependable group, 29; mine, 29, 327
Old Eureka mine, 280, 312
Old Macchaus mine, 371
Old Timer mine, 77
Oligocene, 321
Olson, Roy S., 370
Omega group (see Cerro Gordo mine), 58
Omega mine, 347
Ophir mine, 71, 77, 84
Orange County, 273, 347-349, 482; clay, 277; mineral water, 282; natural gas, 282; natural gas liquids, 283; peat, 282; petroleum, 283; salt, 284; sand and gravel, 284; stone, 286
Ordovician, 115
Oriental mine, 371
Orinda formation, 574, 591; Petroleum Company, Ltd., 591
Orland Sand and Gravel Company, 323
Oro Del Lomas Company, 382
Oro Fino mine (see Shoshone Mines), 80
Oroville Table Mountain, 311
Osborne, J. L., estate, 81, 82
Osceola claim, 372
Otay River, 360
Ousley, C. E., 103
Outlaw group, 352
Overgard, Julia, 77
Oversight claim, 98
Owens, Lieutenant, 19
Owens-Illinois Glass Company, 351, 584; Plant, 345
Owens Lake, 19, 20, 21, 23, 128, 129, 130, 326, 327
Owens Mountain, 490
Owens River, 21
Owens Valley, 18, 19, 20, 21, 22, 23, 99, 108
Owlshead Mountain deposits, 126
Owlshead Mountains, 126

P

Pabst, Dr. Adolph, 625
Pacific Alkali Company (see Pittsburgh Plate Glass Company plant), 130
Pacific Borax Company, 329
Pacific Coast Aggregates, Inc., 309, 322, 353, 362, 367, 368, 369, 383, 503, 529
Pacific Coast Borax Company, 101
Pacific Coast Pumice Company, 127; grinding plant, 127

Pacific Coast Talc mine (see Trinity mine), 120
Pacific Clay Products Company, N. Clark and Sons Division, 311, 315, 362
Pacific Crystals, 131
Pacific Cut Stone and Granite Company, 360
Pacific Gas and Electric Company, 376, 487, 488, 565, 566, 572
Pacific Gypsum Company, 330
Pacific Limestone Products Company, 369
Pacific mine, 312, (see Roosevelt mine), 358
Pacific Minerals Company, 320
Pacific Portland Cement Company, 354, 364
Pacific Sulphur Company, 113
Pacific Tungsten Company, 70
Pacific Western Oil Company, 321
Pacific Zinc Company, 83
Pack, R. W., cited, 491
Padre and Madre mine, 326
Pagan group (see Cerro Gordo mine), 58
Page, Ben M., cited, 113, 115, 116
Painter mine, 500, 502
Palen Mountains, 632
Paleocene formation, 521
Paleozoic, 18, 28, 37, 41, 60, 100, 101, 106, 115, 117, 121
Palermo quarry, 315
Palmer, A. C., 118
Palmer, Raymond, 118
Palmer Creek, 324
Palos Verdes Hills, 333
Panama Pacific Exposition, 476
Panaminas, Incorporated, 86
Panamint claim, 78
Panamint district, 56, 78
Panamint metamorphic complex, 48
Panamint Milling Company, 43
Panamint mines group, 56, 78
Panamint Mountains, 632
Panamint Range, 18, 20, 21, 28, 36, 38, 39, 40, 43, 44, 45, 47, 51, 52, 56, 72, 76, 78, 82, 98, 100, 114, 123, 126, 127, 327, 328
Panamint silver district, 23
Panamint Springs, 50, 57, 58, 71, 75
Panamint Treasure mine, 47
Panamint Valley, 20, 21, 23, 46, 57, 78
Panoche formation, 355, 510; Hills, 486, 490, 506, 507; Pass, 507; Ridge, 490; Valley deposit, 506
Pardee Dam, 527
Parish Brothers, 377, 387
Partini, Steven, 504
Patterson, 378
Patton, Francis E., 109
Paulson (see Donna Loy group), 124
Paynes Creek, 380
Pearch mine, 323
Pearch Creek, 325
Pearl quarry, 345
Peat, 282
Peckham, S. F., cited, 590
Pegma mine (see Death Valley mica mines), 103
Pendola Garden mine, 338
Penn Chemical Company, 316
Penn mine, 316, 597
Pennsylvania mine, 346
Pennsylvanian, 28, 60
Pentz pit, 313
Perlite, 282
Perlite Industries, Inc., 106
Permanente Cement Company, 366, 367; Creek, 367; Metals Corporation, 130, 344

Permit mine, 338
Permit Mining Corporation, 338
Perry, Elmer, 57, 78
Perry lead mine, 78
Peterson, A. H., 90
Peterson, E. C., cited, 55, 60, 68, 80
Peterson, Theodore, 81
Peterson Sand and Gravel (see Buell Flat Rock Company), 367
Petroleum, 283
Petty, William J., 108, 110
Philadelphia claim, 637
Piedra mine, 510
Pine Canyon Spring, 576
Pine Creek, 85, 89, 90, 91, 95, 328; deposit, 91; mill, 86; mine, 19, 84, 86, 91, 92, 282; pendant, 86, 91
Pine Creek Tungsten Company, 91; mine, 37
Pine Flat Dam, 487
Pinole tuff, 573, 577, 578
Pinto Basin, 351, 352
Pioneer Creek, 312
Pioneer Pyrophyllite Company, 111
Pioneer Pyrophyllite Products Company, 360
Pirie-Lion Mountain area, 386
Pit River, 340
Pittsburg Landing, 590
Pittsburg-Liberty mine, 343
Pittsburg mine, 583, 590
Pittsburg Plate Glass Company, 129, 327; plant, 130
Pittsburg Pumibloc Company, 318
Pittsburg Pumice Industries, 578
Pittsburg Sand Company, 583, 590
Placer County, 349-350, 362, 572, 573, 604; clay, 277; gold, 279; sand and gravel, 284; silver, 285; stone, 286
Placerita field, 333
Platinum-group metals, 283
Pleasant Canyon, 38, 45, 47, 48
Pleasant Valley, 321; field, 518, 520
Pleistocene, 23, 83, 109, 386, 489
Pliocene, 317, 376, 489, 517, 574, 577, 585, 587, 591
Plumas County, 350-351; barite, 276; copper, 278; gold, 279; manganese ore, 281; sand and gravel, 284; silver, 285; stone, 286
Plymouth Rock Wool Manufacturing Company, 311, 315
Point Castro, 574
Point Reyes, 563; Station, 336, 337
Point Richmond, 318, 572, 585, 600
Point St. George, 319
Pollard Brothers, 530
Pollock Pines, 321
Pomona Tile Company, 124, 357
Pongo mine, 357
Poorman and Hastings placer mine, 371
Pope Creek, 346
Pope Valley, 345, 346
Port Costa Brick Works, 318, 572
Post Oak mine, 500, 502
Potash, 283
Potrero San Pablo, 564
Poverty Hills, 47
Poway, 360
Powers, John R., 102
Prairie Creek, 325
Prescott, Basil, 48
Price's Peat Humus Company, 348
Pride hydraulic mine, 372
Priest, G. C., 40

Priestley, W. J., 91
Priest Valley, 497
Primer deposit, 637
Primer, George B., 637
Primus (see Iron Cap deposit), 53
Prior, R. D., 510
Proctor, Paul D., cited, 85, 86
Promontory mine (see Darwin Mines), 59, 60
Prospect Mountain quartzite, 628
Protection group, 39
Providence Mountain deposit, 637
Pumice, 283
Pumice Butte, 326
Pumicite, 283
Pumicrete Product Company, 336
Pursell, Dale, 102
Putah Creek, 387, 388
Pyrites, 284
Pyrophyllite, 287

Q

Quackenbush, W. J., 118
Quackenbush lease (see Irish lease), 118
Quatal Canyon, 387
Quaternary, 23, 28, 129, 574
Queen of Sheba (see New Sutherland Divide Mining Company), 76
Quigley, Clarence, 531, 532, 533
Quigley Kings River, 532
Quinn, B., 81

R

Rabbit's Foot claim, 533
Racetrack playa, 37
Radcliff (see Ratcliff) mine, 38
Railing, W. C., 323
Rainbow mine (see Shoshone Mines), 80
Raines, L. H., 632
Raisin City field, 322, 521
Ramona Granite Company, 360
Randsburg district, 329
Raney, M. J. 498
Rankin, C. A., 82
Ratcliff mine, 38, 47, 78
Rattlesnake Bridge, 320
Ray, C. D., 111
Ray, Fred, 325
Recent, 103, 485, 490, 562, 579, 591
Red Bluff deposit, 633
Red Bud limestone, 322, 507, 508
Red Bud mine, 534
Red Cinder Mountain, 111, 327
Red Cloud mine, 78
Red Eagle group, 79
Red Hill hydraulic mine, 381
Red Hill mill, 88
Red Hill mine, 341
Red Jacket group, 333
Red Rock Island, 574
Red Top claim, 59
Redlands Canyon, 51
Redlite Aggregate, Incorporated, operations, 111
Redwood Creek, 325
Reed Flat mine (see Mexican mine), 74
Reeds Creek, 380
Reid, Mrs. Agnes, 57, 78

Reid, William, 57, 78
Reiss, J. A., 533
Reiss, Marguerite, 533
Relief Hill mine, 347
Rench, H. E., cited, 487
Requa, M. L., cited, 592
Reward claim, 83
Reward mine, 38, 48
Rex hydraulic mine, 382
Rhodes, D. A., 130
Rhodes and Manley, 325
Rice Brothers, 380, 388
Richfield Oil Corporation, 363, 364, 365
Richmond Brick Company, 318
Richmond Pressed Brick Company, 573
Richmond Rock Wool Company, 597
Rigg, W. C., 58
Rincon area, 386
Rincon oil field, 273
Rio Vista gas field, 317, 353, 376, 562, 591, 592
Rip Van Winkle mine (see Darwin mines), 59
Rita mine (see Anita or Santa Reta), 511
Riverdale field, 514
River Rock Company, 340
River View Rock Company, 322, 530
Riverside Cement Company, 351
Riverside County, 273, 351-353; cement, 277; clay, 277; copper, 278; gem stones, 278; gold, 279; gypsum, 280; iron ore, 280; lead, 281; mineral water, 282; sand and gravel, 284; silica, 285; silver, 285; stone, 286
Riverside Portland Cement Company, 356
Roaring Lion prospect, 377
Roberts Brothers, 583
Roberts Island, 362
Roberts Sand Company, 583, 590
Robinson, Douglas, 104
Robinson pit, 348
Robinson Ranch, 348
Rockaway Beach, 365
Rocket mine, 84, 276
Rocklite Products Company, 386
Rocky Point group, 40
Rogers, G. P., 117
Rogers, Jack, 101
Rogers, John, 43, 45, 51
Rollins, Robert Z., cited, 505
Roosevelt mine, 358
Rosamond area, 329
Rose, E. M., and Company, Inc., 75
Rose Canyon, 360
Rose Valley, 111
Roselip, Walter B., 363
Ross, Clyde P., cited, 23, 85, 575
Rosser, Fred, 40
Ross-Garcia, 493
Rossi Mill (see Bishop Concentrate and Cleaning Company), 87
Rouff, George, 111
Round Mountain pumice deposit, 109
Round Valley mine, 90, 94, 329
Round Valley pendant, 94
Royal group, 79; (Best) mine, 314, 316
Royer's mill, 40
Runner, D. G., cited, 480
Rush Creek, 350
Russel Ranch field, 365

Russian River, 339, 377
Ruth Hill prospect, 511
Ruth mine, 43, 46, 49, 50
Ryan, V. C., 70
Rynearson, G. A., cited, 493
Ryne mine (see Mount Diablo Quicksilver mine), 563, 575

S

Sacramento Brick Company, 353
Sacramento County, 9, 273, 317, 353-354, 376, 591; clay, 277; gold, 279; natural gas, 282; platinum-group metals, 283; sand and gravel, 284; silver, 285; stone, 286
Sacramento mine, 343
Sacramento River, 317, 343, 364, 370, 380, 381, 563, 592, 594
Sacramento Valley, 578
Saddlebag Lake, 343
St. Charles (see Fernando and St. Charles group), 69
St. George mine, 50
St. Helena Perlite Aggregates Company, 345
St. Lawrence claim, 52
Salinas River, 344
Saline Valley, 21, 114, 116, 121, 128, 129, 327
Salisbury Pass, 106
Sally Ann mine, 37
Salmon River, 374, 375
Salt, 284
Salt Wells Valley, 23
Salton Sea, 325, 326
Salyer Syndicate, 382
Sample mine, 510
Sampson, R. J., cited, 28, 36, 38, 39, 40, 43, 44, 45, 46, 47, 50, 51, 52, 55, 56, 58, 59, 69, 70, 75, 76, 77, 78, 79, 81, 82, 85, 87, 88, 89, 93, 97, 98, 113, 116, 124, 128, 129, 130, 502, 584
San Andreas fault zone, 354, 355, 367
San Benito County, 354-355, 486, 510, 511, 564; antimony, 276; cement, 277; clay, 277; mercury, 281; mineral water, 282; petroleum, 283; sand and gravel, 284; stone, 286.
San Bernardino County, 19, 20, 100, 114, 129, 131, 213, 327, 351, 355, 359, 482, 625; boron minerals, 276; bromine, 276; cement, 277; clay, 277; copper, 278; feldspar, 278; gold, 279; iron ore, 280; lead, 281; lime, 281; lithium minerals, 281; manganese ore, 281; mineral pigments, 282; mineral water, 282; perlite, 282; petroleum, 283; potash, 283; pumice, 284; pumicite, 284; pyrophyllite, 287; salt, 284; sand and gravel, 284; silica, 285; silver, 285; stone, 286; soda, 286; talc, 287; tungsten, 287; zinc, 287
Sanchez Brothers, 316
Sand and gravel, 285
Sand Canyon, 287, 483
Sand Creek, 317
Sanders, E. E., 387
San Diego County, 359-361; abrasive stone, 276; gem stones, 278; gold, 279; magnesium compounds, 281; mineral water, 282; peat, 282; pyrophyllite, 287; salt, 284; sand and gravel, 284; silver, 285; stone, 286
San Diego River, 360
San Dieguito Canyon, 360
San Fernando Valley, 334
San Francisco Bay, 276, 310, 318, 364, 367, 368, 370, 563, 572, 577, 594
San Francisco County, 361, 364; gold, 279; mineral water, 282; silver, 285
San Francisquito Canyon, 334
San Gabriel River, 334
San Joaquin and Eastern Railroad, 508
San Joaquin County, 9, 361-362, 563; clay, 277; gold, 279; natural gas, 282; platinum-group metals, 283; sand and gravel, 284; silver, 285; stone, 286
San Joaquin deposits, 507
San Joaquin formation, 383
San Joaquin mine, 498
San Joaquin oil fields, 600

San Joaquin ridge, 490
San Joaquin River, 321, 322, 336, 343, 486, 487, 488, 490, 492, 503, 504, 525, 526, 528, 530, 531, 562, 563, 566, 579, 584, 592, 594
San Joaquin Valley, 321, 322, 330, 363, 485, 486, 488, 498, 504, 505, 506, 514, 527, 602
San Juan Canyon, 354
San Luis Brick Company, 363
San Luis Obispo County, 273, 363-364, 482; gypsum, 280; mercury, 281; mineral water, 282; natural gas, 282; petroleum, 283; sand and gravel, 284; stone, 286
San Marcos Pass, 365
San Mateo County, 361, 364-365; cement, 277; clay, 277; magnesium compounds, 281; sand and gravel, 284; stone, 286
San Miguelito area, 386
San Pablo Bay, 563
San Pablo Creek, 576
San Pablo mine (see Blake Brothers), 585
San Pablo Ridge, 587
San Pablo Valley, 588, 591
San Ramon Creek, 563
San Vincente Creek, 368
Sanger mine (see Black Canyon mine), 57
Santa Ana Valley Irrigation Company, 348
Santa Barbara County, 273, 363, 365-367, 482, 603; clay, 277; diatomite, 278; mineral water, 282; natural gas, 282; natural gas liquids, 283; petroleum, 283; sand and gravel, 284; stone, 286
Santa Clara County, 273, 345, 367-368, 563; cement, 277; clay, 277; lithium minerals, 281; mercury, 281; petroleum, 283; sand and gravel, 284; stone, 286
Santa Clara River, 385
Santa Cruz Aggregates Company, 368, 369
Santa Cruz County, 9, 10, 368-369; asphalt, native, 276; cement, 277; clay, 277; sand and gravel, 284; serpentine, 285; stone, 286
Santa Cruz Portland Cement Company, 368
Santa Fe Railroad, 330, 565
Santa Fe Rock and Sand Company, 379
Santa Lucia granite, 344
Santa Margarita formation, 368
Santa Maria field, 603
Santa Maria mine (see Cerro Gordo mine), 58
Santa Monica Mountains, 334
Santa Paula Rock Company, 386
Santa Reta (see Anita or Rita), 511
Santa Rosa Island, 365
Santa Rosa mine, 79
Santa Rosa Mining Company, 54, 79
Santa Ynez River, 367
Santiago Canyon, 349
Sara claim, 350
Saratoga Spring, 357
Sarita mine, 343
Saticoy Rock Company, 386
Sausa, L. E., 94
Savell, F. H., 109
Schroder, E. J., cited, 476
Schultz, A., 53
Schmidig, Frank, 333
Schroeder mine, 338
Schultz, Francis, 350
Schwartz and Mitchell, 350
Schwartzgruber, Joe, 387
Sciochetti, Louis, 355
Scoria, 283
Scott River, 375
Seaboard Oil Company, 521
Seal, Donald, 105, 106
Seal Beach field, 334
Searles Lake, 21, 23, 100, 276, 281, 283, 327, 355, 356

Secrest, Carl N., 507
Selby, 41, 49, 71, 335, 338, 358, 381, 385, 562, 594
Selby, Tom, 594
Serpentine, 285
Serra Brothers, 318, 588 ; mine, 588
Serrano pit, 348
Service Rock Company, 529
Shadow Mountain, 637
Shady Creek, 346
Shafter, Ernest A., 45
Shafter, Owen F., 45
Shannon Creek mine (see Marble mine), 90
Shasta County, 273, 369-371, 482, 603 ; asbestos, 276 ; copper, 278 ; gold, 279 ; iron ore, 280 ; lead, 281 ; mineral water, 282 ; platinum-group metals, 283 ; pyrites, 284 ; sand and gravel, 284 ; silver, 285 ; stone, 286 ; zinc, 287
Shasta Dam, 364
Shastalite Block Company, 374
Shaver, Phil, 317
Shaver Reservoir, 488
Shaw mine, 321
Shawnee mine, 314
Sheepshead and Victory tungsten group, 95
Sheepshead Mountain perlite deposit, 105
Shell Oil Company, 514, 565
Shell Oil Company Properties, Inc., 514, 521, 565
Shell Oil Company Refinery, 602
Shell Ridge, 585
Shellmaker, Inc., 347
Shepard, A. P., 502, 505
Shepard, H. N., 87
Sheridan Brothers, 532
Sherlock, M. N., 40
Sherman Peak, 509
Shingle Springs, 320
Shoeppe, W. A., 348
Shoshone mine, 280
Shoshone Mines, 55, 80, 328
Shoshone perlite deposit, 306
Shoshone volcanic ash deposit, 109
Side Hill group, 99
Siebert, F. J., 501
Sienknecht, A. H., 529
Sierra County, 371-373 ; gold, 279 ; sand and gravel, 284 ; silver, 285
Sierralite, 118
Sierra Nevada, 18, 19, 20, 21, 22, 23, 38, 85, 86, 87, 90, 99, 105, 485, 486, 487, 489, 491, 500, 502, 506, 508, 531, 566
Sierra Nevada batholith, 23, 104, 489
Sierra Nevada province, 488, 489, 491
Sierra Talc and Clay Company, 98, 117, 119, 120, 121, 125, 127, 327, 357
Sierra Ventura Mines, Inc., 82
Sierra white feldspar deposit, 99
Siesta formation, 574
Siesta Valley, 587
Signal Oil Company, 60, 69
Silica, 285
Silica Company of California, 584
Silica Sand Company, 583
Silurian, 100, 101
Silver, 285
Silver Bell (see Skidoo mine), 51
Silver Dollar, 119
Silver Hill mine, 358
Silver Lake, 358 ; mine, 357
Silver Mountain, 637
Silver Reef (see Ventura mine), 82

Silver Spear Mining Corporation, 58, 79
Silver Spoon mine, 81
Simonds (see Talc City mine), 119
Simpson, Jack, 531
Sisquoc River, 365
Siskiyou County, 373-376, 482 ; copper, 278 ; diatomite, 278 ; gem stones, 278 ; gold, 279 ; mineral water, 282 ; platinum-group metals, 283 ; pumice, 284 ; sand and gravel, 284 ; scoria, 284 ; silver, 285 ; stone, 286
Siskon Mining Company, 310, 375
Sixteen to One mine, 280, 372
Skidoo mine, 38, 51, 328
Skinner, L. D., 59
Skinner, William, 57, 68, 69
Skinner, W. V., 328
Slab Ranch mine, 316
Slack, Sloan, 69
Slate, 286
Slater (see Serra Brothers), 588
Slate Range, 20, 51, 70, 77, 83, 84, 108, 328 ; district, 19, 55 ; mine (see Gold Bottom mine), 70
Small Boy claim, 59
Smith gravel pit, 346
Smith, Lance, 54
Smith mine, 316, 357
Smith, Sally Ann, 37
Smith, Wellman, 341
Snelling Gold Dredging Company, 340
Snoke, H. R., cited, 478
Snow Canyon, 50
Snyder, Grant, 82
Soapstone, 287
Sobrante formation, 318, 585
Soda, 286
Soft Spot claim, 45
Solano County, 273, 353, 376-377, 565, 591 ; natural gas, 282 ; sand and gravel, 284 ; stone, 286
Somavia and Yant, 333
Somerville, John, 86
Sonoma County, 377-378 ; diatomite, 278 ; mercury, 281 ; mineral water, 282 ; perlite, 283 ; petroleum, 283 ; sand and gravel, 284 ; stone, 286
Sonoma Quicksilver Mines Company, 377
Sonoma volcanics, 345, 377
Sonora Marble Aggregate Company, 312, 315, 384
Sorensen, Walter, 117
Sousa, A. D., 506
South Mountain oil field, 273
South Park Canyon, 72
Southern California Edison Company, 488
Southern California Minerals Company, 357
Southern Death Valley-Kingston Range, 19, 114, 123, 126
Southern Death Valley perlite deposit, 106
Southern Homestake mine, 51
Southern Homestead (Southern Homestake mine), 51
Southern Pacific Milling Company, 366
Southern Pacific Railroad, 20, 105, 108, 112, 130, 309, 320, 327, 340, 341, 352, 378, 529, 565, 583, 584, 604
Southern Sierras Power Company, 78
Southern View mine, 312
Southport Land and Commercial Company, 583
Southwest Lead and Zinc Company, 72
Southwest mine (see Darwin Mines), 59
Southwestern Portland Cement Company, 333, 356
Spanish Peak (see Red Bud mine), 534
Spear (see Royal group), 79
Specimen mine, 338

Split Rock mines, 314
Spooks Canyon, 360
Spreckels, Claus, 10
Spreckels Sugar Company, 15, 567, 574
Spindler, John, 116
Spurr, J. E., cited, 22
Staats, D. E., 106
Staats perlite deposit, 106
Stalker, A. W., 106
Stamm, George, 580
Standard Hills Mines Company, 330
Standard mine, 352
Standard Oil Company, 317, 329, 331, 361, 565 ; Refinery, 600
Standard Tungsten Company mill, 88
Stanislaus County, 378-379 ; clay, 277 ; gold, 279 ; natural gas, 282 ; platinum-group metals, 283 ; sand and gravel, 284 ; silver, 285
Stanislaus River, 316
Star claim, 78
Star coal mine, 581
Stauffer Chemical Company, 113, 356, 603 ; plant, 603
Stephens-Adamson Company, 528
Stephens pit, 388
Stevens, Al, 94
Stevens, Howard, 94
Stevens, M. M., 356
Stewart and Nuss, 322, 503, 530
Stewart, Charles, 530
Stewart, H., 118
Stewart, Louie, 632
Stewart, Ralph, cited, 490, 491
Stewart's Wonder claim, 78
Stivers, Joe, 43, 45
Stock Asbestos Mining Company, 367
Stockton Brick and Tile Company, 362
Stockton Building Materials Company, 362
Stockton Firebrick Company, 604
Stockton Hill mine, 347
Stockwell mine, 51, 328
Stoddard Wells, 357
Stone, 286
Stone Canyon mine, 497
Stone House Ranch, 584
Stoney Creek, 323
Stovepipe Wells, 73
Streger, Mary, 50
Sugar Loaf group, 375
Suisun Bay, 376, 500, 563
Sulfur, 286
Sulfur Bank, 331 ; mine, 332
Sulfur Creek, 346
Sulfur Refiners Incorporated, 113
Sulfur Springs, 576
Sulfur Springs Mountain, 564
Summit Hill mine, 321
Summit No. 2 (see Cerro Gordo mine), 58
Suncrest, 360
Sunrise mine, 352
Sunset group, 350
Sunset mine, 52, 510
Sunshine Gold Mining Company, 370
Sun Valley, 335
Superior-Academy Granite Company, 322, 504
Superior mine, 357
Superior Oil Company, 363, 386
Superjacent series, 490

Superlite Corporation, 326
Surcease Mining Company, 359
Surprise Canyon, 55, 56, 78
Surprise mine, 81, 328
Sur series, 344
Sutherland, Clark, 124
Sutleff, Jess G., 69
Sutter Buttes field, 380
Sutter County, 277, 380 ; clay, 277 ; natural gas, 282 ; sand and gravel, 284
Swanson Mining Corporation, 382
Swatzel, H. C., 512
Swazey, Jose, 347
Sweetwater River, 360
Sycamore Creek, 534
Symons, Henry H., cited, 482

T

Taber, Wm. G., 381
Taff, J. A., cited, 564
Talc, 287
Talc City mine, 114, 115, 117, 119, 120, 122, 327
Taliaferro, N. L., cited, 491
T and H Mortarless Tile Company, 324
Tapo Alto Mountain, 387
Target group, 95
Tassajara Oil Corporation, 591
Taylor (see Panamint Treasure mine), 47
Taylor, H., 118
Taylor, Tom, 83
Teaford, Otis, 507
Teagle, E. E., 51, 52
Technical Porcelain and Chinaware Company, 572
Tecopa Consolidated Mining Company, 80
Tecopa district, 19, 20, 37, 55
Tehama County, 380-381 ; chromite, 277 ; mineral water, 282 ; sand and gravel, 284 ; stone, 286
Tehama formation, 380
Teis, Ruby A., 78
Tejon formation, 567
Telephone Canyon, 52, 127
Telescope group, 48
Telescope Peak, 21, 36
Temblor formation, 321, 517, 518, 520, 521
Terminas Beach Rock Company, 383
Tertiary, 23, 28, 84, 103, 113, 128, 129, 336, 337, 363, 364, 485, 486, 490, 491, 514, 562, 564, 573, 574, 585
Tertiary, pre-, 18, 28, 352
Texaco Company, 364
Texas Gulch mine, 338
Theis, Arthur J., 60
Thermo-phos, 285
Thogwell, H., 107
Thomason, Ira L., cited, 96
Thompson, Ethel, 82
Thompson, J. W., 89
Thompson, R. H., 107
Thompson, Virginia, 372
Thompson and Gordinker plant, 341
Thompson Canyon, 75
Thompson Divide Mining Company, 77, 382
Thompson Materials and Construction Company, 322, 530
Thompson mine (see Darwin Mines), 59, 64
Thomas Creek, 380
Thomas pit, 323
Thorndyke, John, 72

Thornton gas field, 353
Thousand and One mine, 372
Thuemler, R. P., 323
Thurman and Wright, 280; Gold and Dredging Company, 371
Tice shale, 573
Tide Water Associated Oil Company, 518, 565, 602
Tin Mountain, 98
Titanium, 287
Tivy Valley granite pit, 531
Tomales Bay, 337
Tonopah and Tidewater Railroad, 20
Torrance-Redondo area, 334
Towers, Edna M., 122
Towle pit, 349
Trabuco Ranch, 337
Tracy field, 361
Trail Canyon, 28, 39, 95, 327
Transportation (see Old Dependable antimony) mine, 29
Trask, Parker D., cited, 84, 510, 575
Treasure (see Panamint Treasure) mine, 47
Trey of Diamonds claim, 77
Triassic, 18, 23, 100, 491
Trico field, 383
Trinity County, 381-383; gold, 279; sand and gravel, 284; silver, 285; stone, 286
Trinity mine, 114, 120
Trinity River, 381, 382
Triplett and Barton, Inc., 111
Troeger, Roy C., 43, 51, 69, 84, 122
Tropico mill, 48
Tropico mine, 280, 330
Troster, A. F., 40, 41
Trout, W. A., 94
Tucker, E. M., cited, 482
Tucker, W. B., cited, 28, 36, 37, 38, 39, 40, 43, 46, 48, 50, 51, 52, 54, 55, 56, 58, 59, 69, 70, 75, 76, 77, 78, 79, 81, 82, 85, 87, 88, 89, 93, 97, 98, 113, 116, 124, 128, 129, 130, 502, 584
Tucki mine, 52
Tujunga Creek, 334
Tulare County, 19, 277, 383-384, 486; clay, 277; gem stones, 278; gold, 279; natural gas, 282; sand and gravel, 284; silver, 285; stone, 286; tungsten, 287
Tulare Tungsten mine, 383
Tumey Gulch, 322, 505
Tungstar Mines, 88, 90, 95, 329, 343
Tungsten, 287
Tungsten Associated, Ltd., 343
Tungsten Hills, 85, 94, 329
Tungsten Mines Company, 90
Tungsten Products Company, 91
Tunnel Road, 576
Tuolumne County, 312, 315, 384-385, 482; gold, 279; lead, 281; lime, 281; pumicite, 284; sand and gravel, 284; silver, 285; slate, 286; stone, 286
Tuolumne Gold Dredging Company, 280
Tuolumne River, 378, 379
Turnage, C. W. and Sons, 531
Twin City Gravel Company, 346
Twining Laboratories, 513
Twin Lakes deposit, 508
Twin Oaks Valley, 360
Twin Peaks, 361
Twin Pines Mining and Milling Company, 87
Two Bettys mine, 385
Tyson mine, 319

U

Ubehebe Crater, 37, 73
Ubehebe district, 19, 22, 37, 55, 86, 328
Ubehebe Lead Mines Inc., 82
Ubehebe mine, 82
Ubehebe Mountains, 21
Ubehebe Peak, 73, 82
Ukiah Gravel and Cement Company, 339
Uncle Sam group, 502
Uncle Sam mine, 500
Union Brick Company, 360
Union Flat mine, 312
Union Granite Company, 349
Union Mines (see Cerro Gordo mine), 58
Union Oil Company, 565; Refinery, 603
Union Pacific Railroad, 80, 109, 127, 633
United Materials and Richmond Pressed Brick Company, 572
U. S. Attorney General, 131
U. S. Bureau of Land Management, 13
U. S. Bureau of Mines, 85, 273, 276, 282, 283
U. S. Bureau of Reclamation, 362, 486, 527, 528
U. S. Department of Agriculture, 505
U. S. Department of Justice, 131
U. S. Forest Service, 533
U. S. Geological Survey, 21, 115, 358, 625
U. S. Gypsum Company, 326, 352
U. S. Lime Products Corporation, 384
U. S. Naval Ordnance Test Station, 18, 20, 53, 54, 84, 85, 104, 131
U. S. Navy, 13
U. S. Pumice Supply Company, Inc., 342
U. S. Smelting, Refining and Mining Company, 71, 77
U. S. Vanadium Corporation, 91, 92, 282, 328
University of California, 625, 629
Uphill Mining Company, 382
Upper Comanche dredge, 362
Utacala group (see Zinc Hill mine), 82
Utter, John, estate, 90
Uvas Creek, 367

V

Valley Granite Company, 360
Valley Gravel Company, 388
Valley View claim (see Le Cyr iron deposit), 54, 75
Valley View gypsum mine, 506
Valley Wells Station, 625
Vander Leck, Lawrence, cited, 588, 591
Van Loon "fines" pumice deposit, 110
Van Loon, H. A., 110, 327, 342
Vaqueros formation, 520
Venice field, 334
Ventura Avenue field, 273, 602
Ventura County, 273, 329, 385-387, 602; gypsum, 280; natural gas, 282; natural gas liquids, 283; petroleum, 283; sand and gravel, 284; stone, 82
Ventura mine, 82
Ventura Moulding Sand Company, 386
Ventura oil field, 273, 602
Vercoe, Henry B., 501
Veronica Sales Company, 367
Veronica Springs, 367
Ver Planck, William E. Jr., cited, 128
Victorville Lime Rock Company, 356
Victory mine, 114, 120; Tungsten Syndicate (see Target group), 95
Vignich, Tom, 75
Viking talc mine, 121

Visitacion Valley, 365
Vitrified Products Company, 360
Vogt, Oscar, 82
Volcanic Cinder Company, 111, 112
Voorhis, B. W. Jr., 97
Vulcan mine, 280

W

Wabash Mining Company, 500
Wagner, E. W. and Company, 60
Wagner Assets Realization Corporation, 60
Wainscott, William, 110
Walker, Joseph R., 19
Wallace, W. J., 113
Walls, Richard B., 57
Walters, W. M. G., 52
War Eagle mine, 55
War Eagle (see Big Four mine), 57
War Eagle (see Shoshone Mines), 80
Ward (see Piedra mine), 510
Waring, Clarence A., cited, 22, 37, 44, 72, 84, 128, 129, 576
Waring, Gerald A., cited, 512
Warm Springs Canyon, mineral deposits in, 47, 79, 100, 114, 125, 126, 127, 326, 327, 619, 632
Warner, Charles, 379
Warnken, Louis Jr., 79
Warthan Creek prospect, 498
Wasco field, 329
Washington Creek mine, 347
Watkins, Frank, 74
Watts, W. L., cited, 498
Watts Valley, 507
Waucoba Canyon, 21
Waucoba Spring, 97
Waucoba tungsten mine, 96
Waukashau mine, 347
Weaver, C. E., cited, 564, 573, 577
Weaver Creek, 382
Webb, Robert W., cited, 28, 98, 100, 493, 567
Webb and Mingus, 509 ; deposit, 510
Weber Creek, 320
West Baker mine, 329
West Coast Tungsten Company, 70
West End Chemical Company, 100, 327, 356 ; limestone quarry, 102
West Extension claim, 49
West Side field, 514
Western Gravel Company, 367
Western Lime Products Company, 387
Western Metals Company, 36
Western mine, 357
Western Miners, 382
Western Nonmetallic Company, 325
Western Refractories Company, 311
Western Salt Company, 348, 359
Western Talc Company, 109, 357
Western Tile and Supply Company, 367
Western tungsten mill, 89
West Point powerhouse, 311
West Point tunnel, 312
Westgard Pass, 20, 109
Westside Concrete Products Company, 336
Westvaco Chemical Division, Food Machinery Corp., 354
Westvaco Chlorine Products Company, 359
Weymann, A., 131
Wheeler, R. A., 346
White, D. E., cited, 23, 36

White, Luthena, 325
White Chief claim, 124
White Creek, 510
White Eagle mine, 114, 115, 121
White Star mine, 114
White Swan mine, 114, 122
White Mountain deposit, 115, 632
White Mountain mine, 121, 122, 327
White Mountains, 20, 21, 57, 74, 342
Whiterock, 346
Whitlock, Ora E., 633
Whitlock Creek, 338
Whitmore mine, 330
Whitney, J. D., cited, 591
Wilbunt mine, 349
Wilbur, D. L., 587
Wildrose antimony mines, 36
Wildrose Canyon, 20, 28, 36 ; antimony deposits, 23, 36
Wildrose Mining district, 44
Wildrose Springs Resort, 44
Wilhoit, J. W., 88
William, Florence, 69
Williams, Catherine E., 83
Williams, Sarah, 83
Williams Creek, 372
Willow Creek Canyon, 123
Willow Creek mine, 114, 123
Wills, F., 580
Wilsey, Ernest, 321
Wilshire Bishop Creek, 38, 39
Wilshire Oil Company, 518
Wilson, Dr. W. A., 48
Wilson, L. Kenneth, cited, 23, 70
Wilson, Mrs. Dottie, 104
Wilson, Mrs. Nellie, 41
Wilson, Tom, 106
Wind Wheel mine, 385
Wingate Wash, 83, 84 ; manganese deposit, 84
Winters field, 376
Winters Gravel Service, 388
Wishon, A. Emory, 508
Wolfram Ranch, 317
Wolfsen, A. K., 316
Wood, Claude C. Gravel Company, 362
Wood Canyon, 56
Woodring, W. P., cited, 490, 491
Word, T. H., 583
World War I, 60, 86, 531
World War II, 92, 103, 115, 355, 498, 531, 565, 572, 577, 578, 584, 598, 600, 602
Wright, Lauren A., cited, 22, 113, 580, 581, 583
Wright, Royal J., 83
Wruck Brothers and Davis, 323
W-W Pumice Company deposit, 110
Wyandotte Chemical Corporation, 730
Wyoming claim, 56, 78

Y

Yaney mine, 29, 97, 329
Yankee John mine, 371
Yardell, Mrs. Lunsford, 104
Yates, Robert G., cited, 23, 85
Yeisley, W. E., 385
Yellow Jacket Consolidated Gold Mines, Ltd., 372
Ygnacio (see Cerro Gordo mine), 58

Yolo County, 387-388 ; clay, 277 ; mercury, 281 ; natural gas, 282 ; platinum-group metals, 283 ; sand and gravel, 284 ; stone, 286
Yosemite National Park, 337
Yosemite Portland Cement Company, 526
Yosemite Valley, 489
Young, A. (Nick), 374
Young, R. C., 321
Yreka Creek, 374
Yuba Basin, 388
Yuba Consolidated Gold Fields, 279, 314, 375, 388, 389
Yuba County, 346, 388-389 ; gold, 279 ; platinum-group metals, 283 ; sand and gravel, 284 ; silver, 285
Yuba Manufacturing Company, 504
Yuba River, 279, 371, 388, 389 ; Sand Company, 388

Z

Zapato Creek, 322, 530
Zayante Creek, 368
Zinc, 287
Zinc Hill, 55, 69, 82 ; mine, 82

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STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES

JOURNAL
VOL. 47, NUMBER 4, PLATE 40

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SUMMARY OF ECONOMIC GEOLOGY OF CONTRA COSTA COUNTY

GEOLOGIC AGE		FORMATIONS	DISTRIBUTION	ROCK TYPES	MINERAL DEPOSITS
QUATERNARY	Recent	Salt marsh deposits	Tidal land	Silt and clay	Peat
		Travertine	Lime Ridge SE of Concord	Spring deposited limestone	Limestone
		Temescal	Valleys and stream bottoms	Soil, sand and gravel	Sand and gravel
		Sand dunes	River bank east of Antioch	Wind-blown sand	Sand
	Pleistocene	Montezuma	North flank of Los Medanos Hills	Clay, sand and gravel	Sand and gravel
		Millerton	Between Oleum and Point Pinole	Clay, sand and gravel	
TERTIARY	Pliocene	Mulholland Bald Peak basalt Siesta Moraga	Along western county line northeast of Oakland	Volcanics: basalt and andesite flows, tuffs; limestone, conglomerate, sandstone, clay shales	Clay Limestone Stone
		Tassajero Green Valley Alamo	South of Mount Diablo	Sandstone, siltstone, sand and gravel	
		Orinda	In belt several miles wide east of western county boundary; SW. of Mount Diablo	Fresh water sediments, conglomerate, sandstone, clay shale, volcanic tuff, lignite	Asphalt Clay
		Lawlor and Pinole tuffs	North flank Los Medanos Hills, at and south of Pinole; E. and SW. of Walnut Creek	Water-laid pumice and pumicite	Pumice
TERTIARY	Miocene	San Pablo group Neroly Cierbo Briones	NE. and SW. of Mount Diablo; from San Pablo Bay at Pinole through Walnut Creek along both sides of San Ramon Valley	Marine sandstone, volcanic tuff	Diatomite Limestone Clay
		Monterey group Rodeo shale Hambre sandstone Tice shale Oursan sandstone Claremont shale Sobrante sandstone	In broad southeasterly-trending belt extending from San Pablo Bay and Carquinez Strait through Walnut Creek; along the SW. side of Mount Diablo; Oakland-Berkeley Hills	Marine sediment, sandstone, bituminous shale, chert, limestone	
	Oligocene	Concord Kirker San Ramon	Sobrante anticline at northern end of Briones Valley	Foraminiferal and diatomaceous marine shale	
	Eocene and Paleocene	Undifferentiated, including: Markley Domengine Meganos Martinez	North and northeast of Mount Diablo and widespread in central part of Contra Costa Hills	Sandstone, shale, conglomerate	Clay Coal Glass and foundry sand Natural gas
MESOZOIC	Cretaceous	Undifferentiated, including: Chico Shasta	A broad belt extending SE from Mount Diablo; along county line east of Oakland; at, and SE of Crockett	Shale, arkosic sandstone, limestone	Clay Limestone
	Upper Jurassic	Knoxville	North slope of Mount Diablo; west slope of Oakland-Berkeley Hills	Shale, sandstone, limestone	Clay Limestone
		Franciscan	Central Mount Diablo; Point Richmond Bay islands; north of Berkeley, along front of hills	Hard gray sandstone, serpentine, basalt, chert, conglomerate, shale, and schist	Asbestos Chromite Clay Copper Manganese Mercury Stone

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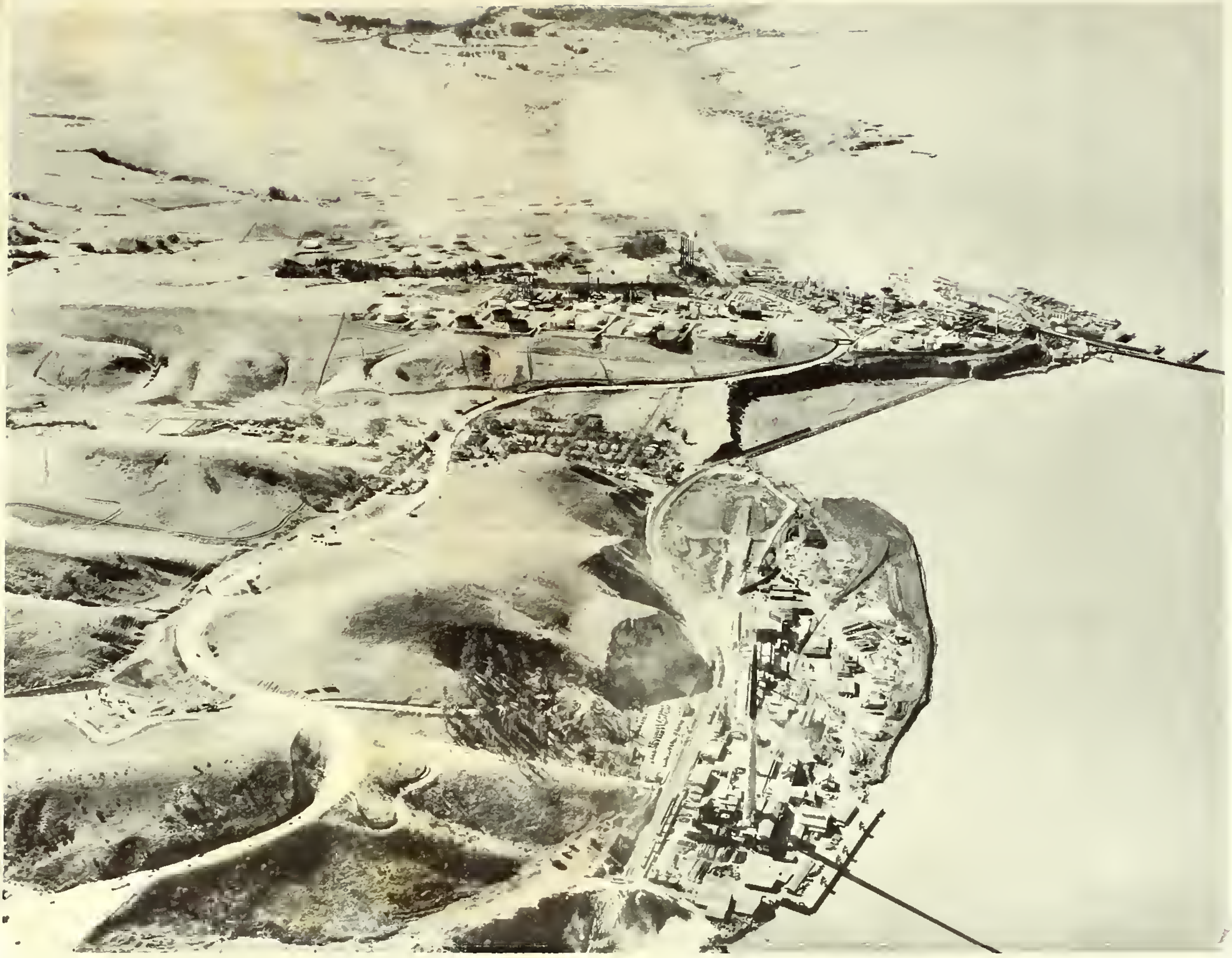
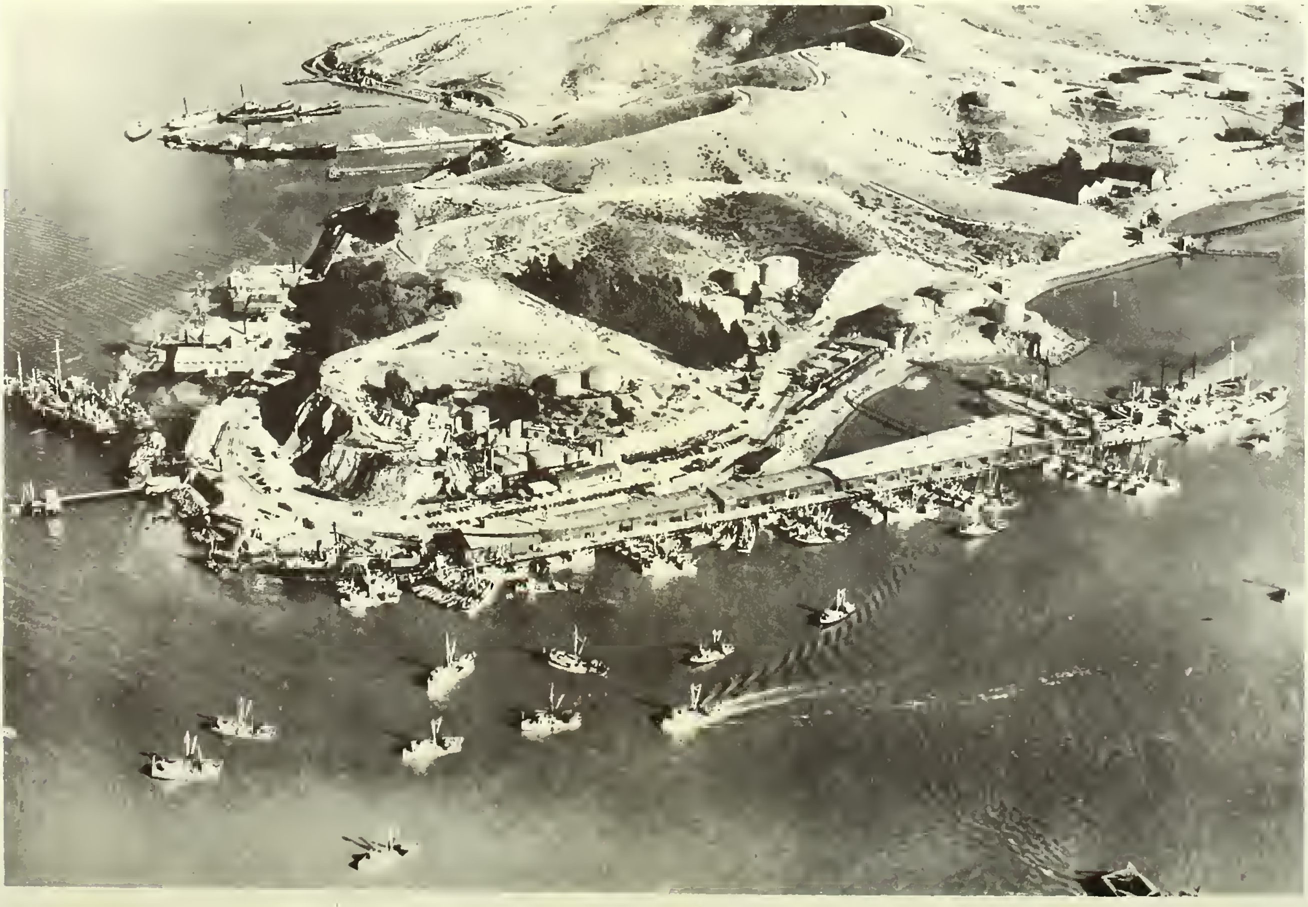


A, AERIAL VIEW SOUTHWEST DOWN THE SHORE OF SAN PABLO BAY

Selby smelter of American Smelting and Refining Company in right foreground, Oleum refinery of Union Oil Company in the middle ground, and town of Rodeo in the background. Subdued hills in the foreground are made up of marine Cretaceous and Paleocene sediments. Those in the vicinity of Rodeo are gently folded upper Miocene and Quaternary marine sediments. *Photo by Clyde Sunderland, Aerial Photographs, Oakland, California.*



B, AERIAL VIEW NORTH ACROSS POINT SAN PABLO

Photo shows installations and dock facilities of Standard Oil Company of California. Rocks exposed are sandstone and shales of the Franciscan formation. *Photo by Clyde Sunderland, Aerial Photographs, Oakland, California.*

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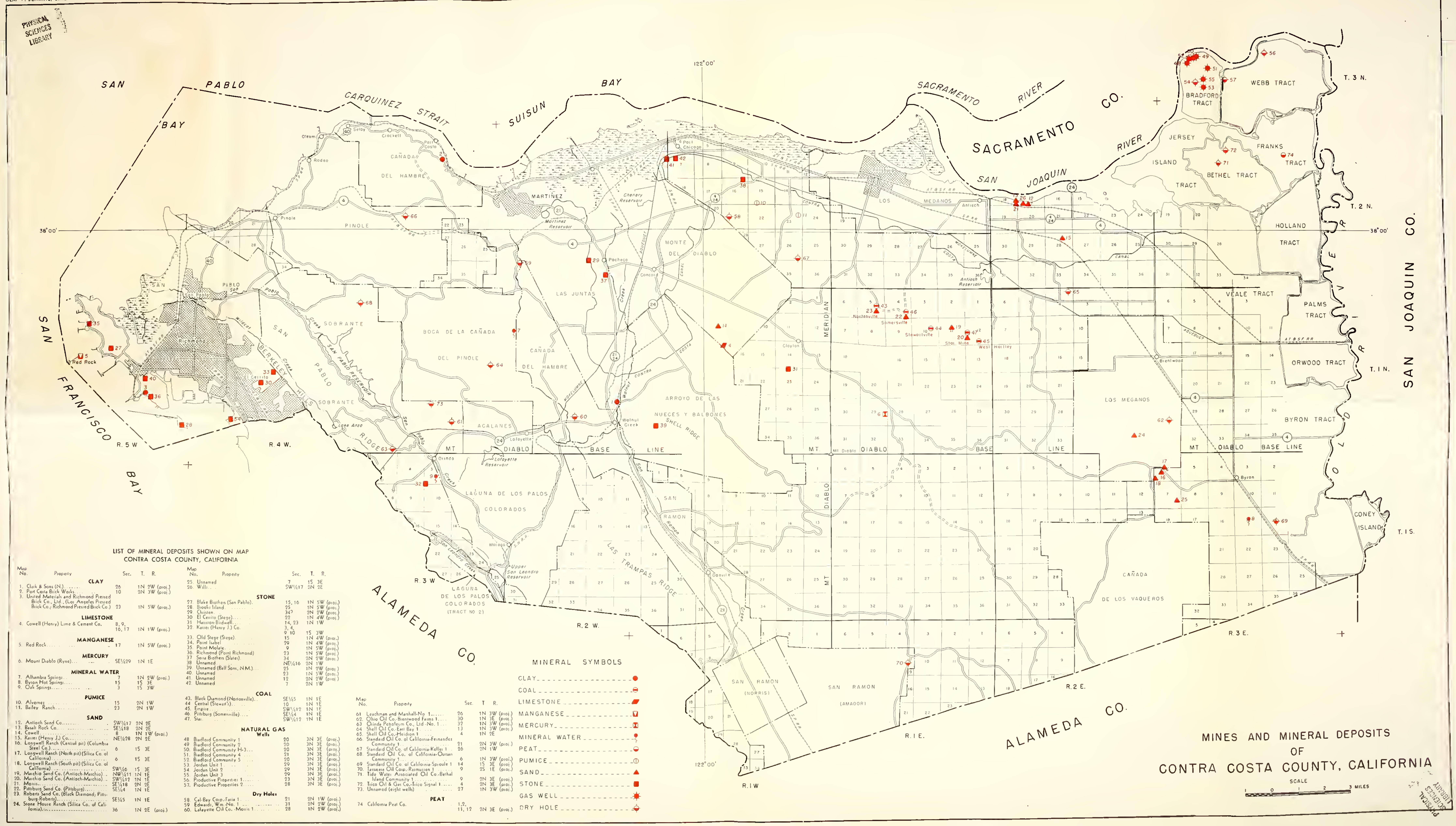
SAN PABLO BAY
CARQUINEZ STRAIT
SUISUN BAY
SACRAMENTO RIVER
SACRAMENTO CO.
SAN JOAQUIN RIVER
SAN JOAQUIN CO.
OLD RIVER
SAN FRANCISCO BAY
ALAMEDA CO.
122°00'
38°00'
T. 3 N.
T. 2 N.
T. 1 N.
T. 1 S.
R. 5 W.
R. 4 W.
R. 3 W.
R. 2 W.
R. 1 W.
R. 1 E.
R. 2 E.
R. 3 E.
MT. DIABLO BASE LINE
MT. DIABLO MERIDIAN
WEBB TRACT
BRADFORD TRACT
JERSEY ISLAND
FRANKS TRACT
BETHEL TRACT
HOLLAND TRACT
VEALE TRACT
PALMS TRACT
ORWOOD TRACT
BYRON TRACT
CONEY ISLAND
LOS MEDANOS
MONTE DEL DIABLO
LAS JUNTAS
CAÑADA DEL HAMBRE
PINOLE
SAN PABLO
SOBRANTE
BOCA DE LA CAÑADA DEL PINOLE
ARROYO DE LAS NUECES Y BOLBONES
ACALANES
LAGUNA DE LOS PALOS COLORADOS
SAN RAMON
LOS MEGANOS
CAÑADA DE LOS VAQUEROS
SAN RAMON (NORRIS)
SAN RAMON (AMADOR)
LAS TRAMPAS RIDGE
SHELL RIDGE
SAN PABLO RIDGE
BERKELEY HILLS
Martinez
Port Chicago
Pittsburg
Antioch
Concord
Pacheco
Clayton
Walnut Creek
Lafayette
Orinda
Moraga
Danville
Richmond
El Cerrito
Pinole
Rodeo
Oleum
Selby
Crockett
Port Costa
Nortonville
Somersville
Stewartville
West Hartley
Brentwood
Byron
Red Rock
Martinez Reservoir
Lafayette Reservoir
San Pablo Reservoir
Upper San Leandro Reservoir
Antioch Reservoir

LIST OF MINERAL DEPOSITS SHOWN ON MAP CONTRA COSTA COUNTY, CALIFORNIA

Map No.	Property	Sec.	T.	R.
	CLAY			
1.	Clark & Sons (N.)	26	1N	2W (proj.)
2.	Port Costa Brick Works	10	2N	3W (proj.)
3.	United Materials and Richmond Pressed Brick Co., Ltd., (Los Angeles Pressed Brick Co.; Richmond Pressed Brick Co.)	23	1N	5W (proj.)
	LIMESTONE			
4.	Cowell (Henry) Lime & Cement Co.	8, 9, 16, 17	1N	1W (proj.)
	MANGANESE			
5.	Red Rock	17	1N	5W (proj.)
	MERCURY			
6.	Mount Diablo (Ryne)	SE¼29	1N	1E
	MINERAL WATER			
7.	Alhambra Springs	7	1N	2W (proj.)
8.	Byron Hot Springs	15	1S	3E
9.	Oak Springs	3	1S	3W
	PUMICE			
10.	Alvemez	15	2N	1W
11.	Bailey Ranch	23	2N	1W
	SAND			
12.	Antioch Sand Co.	SW¼17	2N	2E
13.	Basalt Rock Co.	SE¼18	2N	2E
14.	Cowell	8	1N	1W (proj.)
15.	Kaiser (Henry J.) Co.	NE¼28	2N	2E
16.	Longwell Ranch (Central pit) (Columbia Steel Co.)	6	1S	3E
17.	Longwell Ranch (North pit) (Silica Co. of California)	6	1S	3E
18.	Longwell Ranch (South pit) (Silica Co. of California)	SW¼6	1S	3E
19.	Marchio Sand Co. (Antioch-Marchio)	NW¼11	1N	1E
20.	Marchio Sand Co. (Antioch-Marchio)	SW¼12	1N	1E
21.	Morris	SE¼18	2N	2E
22.	Pittsburg Sand Co. (Pittsburg)	SE¼4	1N	1E
23.	Roberts Sand Co. (Black Diamond, Pittsburg-Roberts)	SE¼5	1N	1E
24.	Stone House Ranch (Silica Co. of California)	36	1N	2E (proj.)
25.	Unnamed	7	1S	3E
26.	Wills	SW¼17	2N	2E
	STONE			
27.	Blake Brothers (San Pablo)	15, 16	1N	5W (proj.)
28.	Brooks Island	25	1N	5W (proj.)
29.	Christen	34?	2N	2W (proj.)
30	El Cerrito (Stege)	22	1N	4W (proj.)
31	Harrison-Birdwell	14, 23	1N	1W
32.	Kaiser (Henry J.) Co.	3, 4, 9 10	1S	3W
33.	Old Stege (Stege)	15	1N	4W (proj.)
34.	Point Isabel	29	1N	4W (proj.)
35.	Point Molate	9	1N	5W (proj.)
36.	Richmond (Point Richmond)	23	1N	5W (proj.)
37	Serra Brothers (Slater)	34	2N	2W (proj.)
38	Unnamed	NE¼16	2N	1W
39.	Unnamed (Ball Sons, N.M.)	25	1N	2W (proj.)
40.	Unnamed	23	1N	5W (proj.)
41.	Unnamed	12	2N	2W (proj.)
42.	Unnamed	7	2N	1W
	COAL			
43.	Black Diamond (Nortonville)	SE¼5	1N	1E
44	Central (Steward's)	10	1N	1E
45.	Empire	SW¼12	1N	1E
46.	Pittsburg (Somersville)	SE¼4	1N	1E
47.	Star	SW¼12	1N	1E
	NATURAL GAS Wells			
48	Bradford Community 1	20	3N	3E (proj.)
49	Bradford Community 2	20	3N	3E (proj.)
50.	Bradford Community H-3	20	3N	3E (proj.)
51.	Bradford Community 4	21	3N	3E (proj.)
52.	Bradford Community 5	20	3N	3E (proj.)
53.	Jordan Unit 1	29	3N	3E (proj.)
54.	Jordan Unit 2	29	3N	3E (proj.)
55.	Jordan Unit 3	29	3N	3E (proj.)
56.	Productive Properties 1	23	3N	3E (proj.)
57.	Productive Properties 2	28	3N	3E (proj.)
	Dry Holes			
58.	Cal-Bay Corp.-Faria 1	21	2N	1W (proj.)
59	Edwards, Wm.-No. 1	31	2N	2W (proj.)
60.	Lafayette Oil Co.-Morris 1	28	1N	2W (proj.)
61	Leachman and Marshall-No 1	26	1N	3W (proj.)
62.	Ohio Oil Co.-Brentwood Farms 1	30	1N	3E (proj.)
63	Orinda Petroleum Co., Ltd.-No. 1	32	1N	3W (proj.)
64	Shell Oil Co.-East Bay 1	13	1N	3W (proj.)
65.	Shell Oil Co.-Heidron 1	4	1N	2E
66.	Standard Oil Co. of California-Fernandez Community 1	21	2N	3W (proj.)
67	Standard Oil Co. of California-Keller 1	26	2N	1W
68.	Standard Oil Co. of California-Oursen Community 1	6	1N	3W (proj.)
69	Standard Oil Co. of California-Sproule 1	14	1S	3E (proj.)
70.	Tassajara Oil Corp.-Rasmussen 1	9	2S	1E (proj.)
71.	Tide Water Associated Oil Co.-Bethel Island Community 1	9	2N	3E (proj.)
72.	Trico Oil & Gas Co.-Trico Signal 1	4	2N	3E (proj.)
73.	Unnamed (eight wells)	27	1N	3W (proj.)
	PEAT			
74	California Peat Co.	1, 2, 11, 12	2N	3E (proj.)

MINERAL SYMBOLS

CLAY	●
COAL	⊖
LIMESTONE	▰
MANGANESE	▽
MERCURY	⧗
MINERAL WATER	⚲
PEAT	◒
PUMICE	⦶
SAND	▲
STONE	■
GAS WELL	✹
DRY HOLE	⊕

MINES AND MINERAL DEPOSITS OF CONTRA COSTA COUNTY, CALIFORNIA

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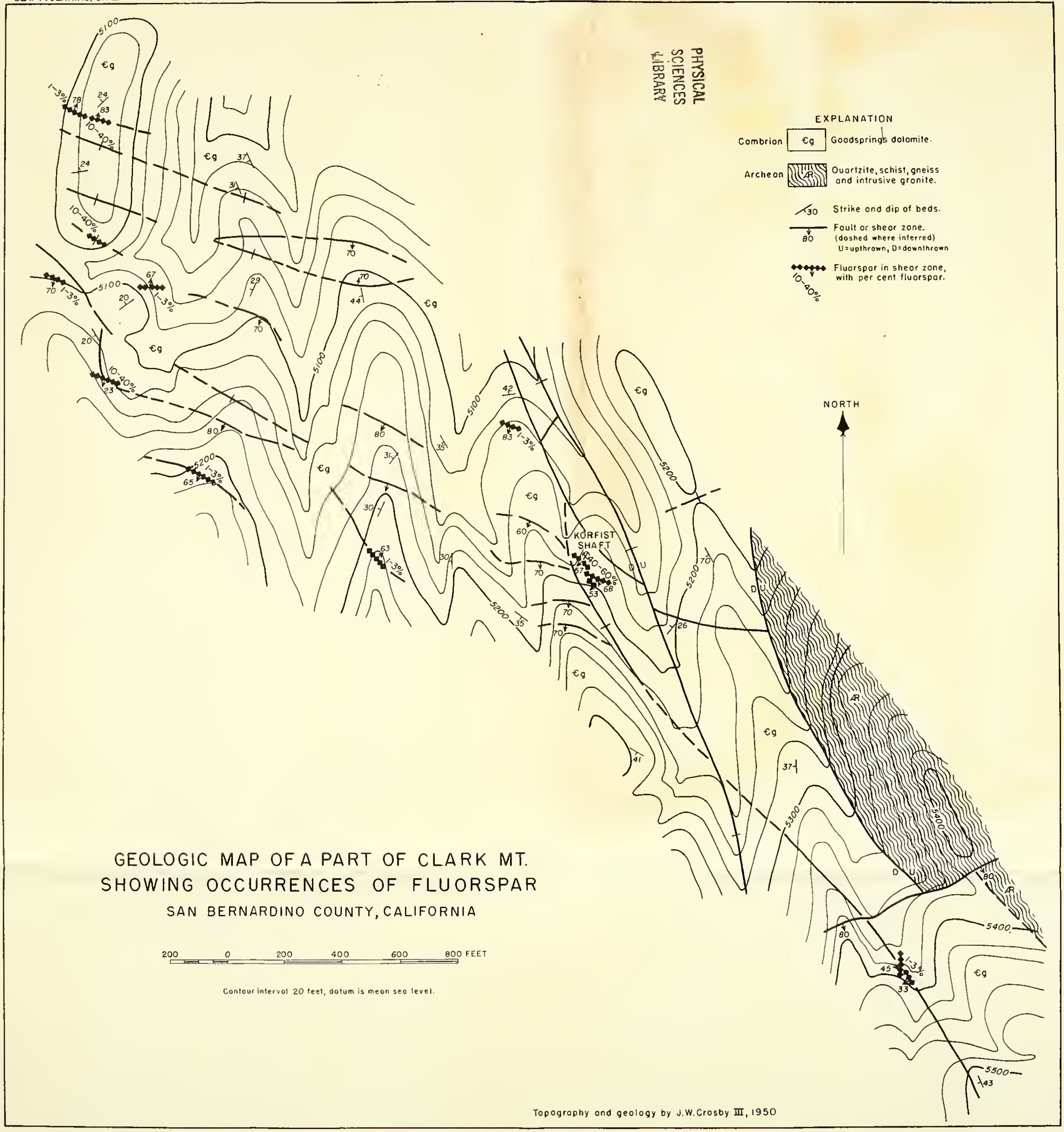
EXPLANATION
Cambrian
Єg
Goodsprings dolomite.
Archean
AR
Quartzite, schist, gneiss and intrusive granite.
30
Strike and dip of beds.
80
Fault or shear zone. (dashed where inferred)
U=upthrown, D=downthrown
10-40%
Fluorspar in shear zone, with per cent fluorspar.
NORTH
KORFIST SHAFT
40-60%
10-40%
1-3%
5100
5200
5300
5400
5500
Єg
AR
D
U
200
0
200
400
600
800 FEET

GEOLOGIC MAP OF A PART OF CLARK MT. SHOWING OCCURRENCES OF FLUORSPAR

SAN BERNARDINO COUNTY, CALIFORNIA

Contour interval 20 feet, datum is mean sea level.

Topography and geology by J. W. Crosby III, 1950

STATE OF CALIFORNIA
EARL WARREN, Governor
DEPARTMENT OF NATURAL RESOURCES
WARREN T. HANNUM, Director

DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO 11
OLAF P. JENKINS, Chief

Publications
# of the
California State Division of Mines

(To March 1, 1951)

Supplement to the
California Journal of Mines and Geology
for April 1951

9—30065

PUBLICATIONS OF THE CALIFORNIA STATE DIVISION OF MINES *

OUTLINE OF REPORT

Page
Introduction ---- 1
Maps ---- 3
Special publications ---- 4
Preliminary reports ---- 6
Register of mines ---- 7
Reports of the State Mineralogist ---- 9
California Journal of Mines and Geology ---- 38
Bulletins ---- 42
Special reports ---- 60
List of depository libraries showing their holdings of Division of Mines publications 61
Finding list of authors ---- 79
Finding list of subjects ---- 89

INTRODUCTION

The principal publications of the California State Division of Mines are *Bulletins*, *Special Reports*, and the quarterly *California Journal of Mines and Geology*, issued in January, April, July, and October of each year. A monthly news release, *Mineral Information Service*, designed to inform the public of discoveries, operations, markets, statistics, and new publications concerning the mineral resources and industry of California, is distributed to the public free upon request. The latter, however, is not part of the regular publication series.

This paper contains a complete list of publications issued by the California State Division of Mines [1] to July 1, 1948. These publications include maps (M), special publications (SP), preliminary reports (PR), registers of mines (RM), reports of the State Mineralogist (R), California Journal of Mines and Geology (J) (which supersedes the reports of the State Mineralogist), bulletins (B), and special reports (SR).

For the convenience of persons who wish to consult publications of the Division of Mines, a list of library holdings is included in this report.[2] Libraries may obtain, on temporary loan, most Division publications which are not among their holdings by writing to the Librarian, California State Library, Sacramento, California.

In ordering publications, please give both series designation, as Bulletin 133, and the title. Give full address, plainly written. Prepayment is required, preferably in the form of money order or cashier's check; make remittance payable to State Division of Mines. Address remittances to California State Division of Mines, Ferry Building, San Francisco 11, California. Please do not send stamps, currency, or personal check. There is no charge for postage.

California residents should add 3 percent sales tax to list price of all publications except monthly or quarterly issues of *Reports of the State Mineralogist* and *Journals*, and subscriptions to the *Journal*.

---

* Prepared by Elisabeth L. Egenhoff, Beth Collins, and Mary-Louise Burgess. This list includes all publications issued prior to March 1, 1951, and supersedes all previous lists of publications.

[1] Designated California State Mining Bureau, 1880-1927; California State Division of Mines and Mining, 1927-29.

[2] Libraries not included in the listing are invited to submit a record of their holdings of Division of Mines publications for inclusion in future editions of this report.

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1.84- 2.16	.06	8.50- 8.83	.26	15.17- 15.49	.46
2.17- 2.49	.07	8.84- 9.16	.27	15.50- 15.83	.47
2.50- 2.83	.08	9.17- 9.49	.28	15.84- 16.16	.48
2.84- 3.16	.09	9.50- 9.83	.29	16.17- 16.49	.49
3.17- 3.49	.10	9.84-10.16	.30	16.50- 16.83	.50
3.50- 3.83	.11	10.17-10.49	.31	16.84- 17.16	.51
3.84- 4.16	.12	10.50-10.83	.32	17.17- 17.49	.52
4.17- 4.49	.13	10.84-11.16	.33	17.50- 17.83	.53
4.50- 4.83	.14	11.17-11.49	.34	17.84- 18.16	.54
4.84- 5.16	.15	11.50-11.83	.35	18.17- 18.49	.55
5.17- 5.49	.16	11.84-12.16	.36	18.50- 18.83	.56
5.50- 5.83	.17	12.17-12.49	.37	18.84- 19.16	.57
5.84- 6.16	.18	12.50-12.83	.38	19.17- 19.49	.58
6.17- 6.49	.19	12.84-13.16	.39	19.50- 19.83	.59

PLEASE NOTE: ALL PUBLICATIONS MARKED WITH AN ASTERISK (*) ARE OUT OF PRINT; PRICES FOR THOSE THAT ARE STILL AVAILABLE ARE GIVEN IN THE LIST.

MAPS (M) †

*1. Preliminary mineralogical and geological map of the State of California, showing also private land grants, scale 1″ = 21 mi., 1891.

*2. Map of forest reserves in California, scale 1″ = 20 mi., 1907.

*3. Relief and mineral maps of California showing the topography and the approximate locations of all the principal mineral deposits together with the statistics of mineral production, scale 1″ = 30 mi., 1908.

*4. Map of Minaret district, Madera County, California, scale 1″ = 12 mi., 1908.

*5. Map of Madera County, California, showing boundaries of the National Forests, scale 1″ = 3 mi., 1909.

*6. Map of Placer County, California, showing boundaries of the National Forests, scale 1″ = 3 mi. (approx.), 1909.

*7. Map of Shasta County, California, showing boundaries of the National Forests, scale 1″ = 3 mi., 1909.

*8. Map of Sierra County, California, showing boundaries of the National Forests, scale 1″ = 1½ mi., 1909.

*9. Map of Siskiyou County, California, showing boundaries of the National Forests, scale 1″ = 4 mi., 1909.

*10. Map of Trinity County, California, showing boundaries of the National Forests, scale 1″ = 2 mi., 1909.

*11. Map of Tuolumne County, California, showing boundaries of the National Forests, scale 1¼″ = 3 mi., 1909.

*12. Map of El Dorado County, California, showing boundaries of the National Forests, scale 1″ = 2 mi., 1909.

*13. Map of California showing the approximate location of the principal mineral deposits, scale 1″ = 12 mi., 1911.

*14. Geological map of Inyo County, California, by C. A. Waring, scale 1″ = 4 mi., 1917.

*15. Map of southern portion of California showing the saline deposits and the desert sections of the state, scale 1″ = 12 mi. (approx.), 1905.

*16. Map of northern California, showing rivers and creeks which produced placer gold in 1932, scale 1″ = 20 mi. (approx.), by J. F. Bongard. Reprinted in Bulletin 135, as pl. 4.

17. Geologic map of California, scale 1″ = 8 mi., prepared under the direction of Olaf P. Jenkins, 1938. In six sheets, 32″ x 42″; sheets not sold separately. Lithographed in colors. Price, unmounted, $4.00.

18. Outline geologic map of California showing locations of quicksilver properties (Economic mineral map of California No. 1—quicksilver), scale 1:1,000,000, prepared under the direction of Olaf P. Jenkins, 1939. Price 50¢.

19. Outline geologic map of California showing locations of chromite properties (Economic mineral map of California No. 3—chromite), scale 1:1,000,000, prepared under the direction of Olaf P. Jenkins, 1942. Price 60¢.

---

† Maps listed hereunder are separate publications; those issued in connection with a bulletin, report, journal, or other publication are listed under that publication. See *Finding List of Subjects*, under MAPS.

*** All publications marked with an asterisk (*) are out of print and cannot be obtained from the Division of Mines. Please do not send any money for publications so marked.**

SPECIAL PUBLICATIONS (SP)

*1. First annual catalogue of the State Museum of California, being the collections made by the State Mining Bureau during the year ending April 16, 1881. 1888. 220 pp. (Revised edition; only one available).

*2. Contributions to the geology and mineralogy of California, by Wm. P. Blake. 1881. 15 pp.

*3. Catalogue of books, maps, lithographs, photographs, etc., in the library of the State Mining Bureau at San Francisco, May 15, 1884. 19 pp.

*4. Catalogue of the State Museum of California, vol. 2, being the collections made by the State Mining Bureau, from April 16, 1881 to May 15, 1884. 1884. 220 pp.

*5. Catalogue of the State Museum of California, vol. 3, being the collections made by the State Mining Bureau, from May 15, 1884 to March 31, 1887. 1887. 195 pp.

*6. Catalogue of the State Museum of California, vol. 4, being the collections made by the State Mining Bureau, from March 31, 1887 to August 20, 1890. 1890. 261 pp.

*7. Catalogue of the library of the California State Mining Bureau, San Francisco, Cal. September 1, 1892. 149 pp.

*8. Catalogue of west North American and many foreign shells with their geographical ranges, by J. G. Cooper. April 1894. 153 pp., Supplement 18 pp.

*9. Catalogue of the State Museum of California, vol. 5, being the collections made by the State Mining Bureau, from September 1, 1890 to March 30, 1897. 1899. 292 pp.

*10. Report of Board of Trustees for four years ending September, 1900. A. S. Cooper, State Mineralogist. 1901. 15 pp.

11. Reconnaissance of the Colorado Desert mining district, by Stephen Bowers, 1901. 19 pp., 2 illus. Price 25¢.

*12. Minerals of California and county atlas. 1902. 56 pp., 25 illus.

*13. Report of the Board of Trustees covering the fifty-second fiscal year ending June 30, 1901, and fifty-third fiscal year ending June 30, 1902. 1902. 17 pp.

Includes: General Appropriation Act providing for the support of the State Government for the fifty-second and fifty-third fiscal years, p. 2; Report of Board of Trustees of State Mining Bureau, pp. 3-12; Report of the State Mineralogist, by Lewis E. Aubury, pp. 13-17.

*14. Report of the Board of Trustees covering the fifty-fourth fiscal year ending June 30, 1903, and fifty-fifth fiscal year ending June 30, 1904. 1904. 14 pp.

Includes: General Appropriation Act providing for the support of the State Government for the fifty-fourth and fifty-fifth fiscal years, p. 2; Report of Board of Trustees of State Mining Bureau, pp. 3-8; Report of the State Mineralogist, by Lewis E. Aubury, pp. 9-14.

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* All publications marked with an asterisk (*) are out of print and cannot be obtained from the Division of Mines. Please do not send any money for publications so marked.

*15. Report of the Board of Trustees and State Mineralogist covering the fifty-sixth fiscal year ending June 30, 1905, and fifty-seventh fiscal year ending June 30, 1906. 1906. 20 pp.

Includes: Report of the Board of Trustees of the State Mining Bureau, pp. 3-7; Report of the State Mineralogist, by Lewis E. Aubury, pp. 8-19.

*16. Report of the Board of Trustees and State Mineralogist covering the fifty-eighth fiscal year ending June 30, 1907, and fifty-ninth fiscal year ending June 30, 1908. 1908. 27 pp.

Includes: Report of the Board of Trustees of the State Mining Bureau, pp. 3-10; Biennial report of the State Mineralogist, by Lewis E. Aubury, pp. 11-26.

*17. Report of the Board of Trustees and State Mineralogist covering the sixtieth fiscal year ending June 30, 1909, and sixty-first fiscal year ending June 30, 1910. 1910. 27 pp.

Includes: Report of the Board of Trustees of the State Mining Bureau, pp. 3-10; Biennial report of the State Mineralogist, by Lewis E. Aubury, pp. 11-27.

*18. Biennial report of the State Mineralogist, Chief of the Division of Mines, for the period July 1, 1946 to June 30, 1948. 1949. 73 pp., 3 figs.

Includes: Annual report, Division of Mines, for the ninety-eighth fiscal year, July 1, 1946 to June 30, 1947, by Olaf P. Jenkins, pp. 365-412, 3 figs.; Annual report, Division of Mines, for the ninety-ninth fiscal year, July 1, 1947 to June 30, 1948, by Olaf P. Jenkins, pp. 7-29; Public Resources Code, pp. 411-415.

*19. California mineral production for 1923, with comparative 1922 data, American Mining Congress Edition. 1924. 4 pp. (Advance figures from Bulletin No. 94.)

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PRELIMINARY REPORTS (PR)

*1. Notes on damage by water in California oil fields. 1914. 4 pp.
Contains: Introduction, by F. McN Hamilton, p. 1; Coalinga field, by R. P. McLaughlin, pp. 1-4.

*2. Notes on damage by water in California oil fields. 1914. 4 pp.
Contains: Introduction, by F. McN Hamilton, p. 1; Midway and Sunset fields, by R. P. McLaughlin, pp. 2-4.

3. Manganese and chromium, by E. S. Boalich. *1st ed., 1917. 32 pp., 1 illus. 2d ed., 1918. 46 pp., 2 illus. Price 25¢.

*4. Tungsten, molybdenum and vanadium, by E. S. Boalich and W. O. Castello. 1918. 44 pp.

*5. Antimony, graphite, nickel, potash, strontium, tin, by E. S. Boalich and W. O. Castello. 1918. 44 pp.

*6. A review of mining in California during 1919, by Fletcher Hamilton. 1920. 43 pp., 1 illus.

*7. The clay industry in California, by E. S. Boalich, W. O. Castello, Emile Huguenin, C. A. Logan, W. Burling Tucker. 1920. 102 pp., 25 illus.

*8. A review of mining in California during 1921, by Fletcher Hamilton. 1922. 68 pp., 1 illus.

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REGISTER OF MINES (RM)

*1. Register of mines and minerals, County of Calaveras, California, by M. B. Kerr. 1900. 27 pp., 1 map.

Contains: Map of Calaveras County, scale 1″ = 2 mi., by H. W. H. Penniman.

*2. Register of mines and minerals, County of Plumas, California, by J. A. Edman. 1900. 21 pp., 1 map.

Contains: Map of Plumas County, scale 1″ = 2 mi.

*3. Register of mines and minerals, County of Siskiyou, California, by J. M. Davidson. 1900. 27 pp., 1 map.

Contains: Map of Siskiyou County, scale 1″ = 4 mi. (approx.).

*4. Register of mines and minerals, County of Trinity, California, by W. S. Lowden. 1900. 25 pp., 1 map.

Contains: Map of Trinity County, scale 1″ = 2 mi.

*5. Register of mines and minerals, County of Nevada, California, by Charles E. Uren. 1901. 12 pp., 1 map.

Contains: Map of Nevada County, scale 1″ = 2 mi.

*6. Register of mines and minerals, El Dorado County, California, by J. F. Armstrong. 1902. 17 pp., 2 maps.

Contains: Map of El Dorado County, scale 1″ = 2 mi.; Economic and geological map of El Dorado County, p. 1.

*7. Register of mines and minerals, Inyo County, California, by A. V. Davidson. 1902. 14 pp., 1 map.

Contains: Map of Inyo County, scale 1″ = 5 mi.

*8. Register of mines and minerals, Lake County, California, by George Madeira. 1902. 9 pp., 1 map.

Contains: Map of Lake County, scale 1″ = 2½ mi. (approx.).

*9. Register of mines and minerals, Placer County, California, by Ivan H. Parker. 1902. 13 pp., 1 map.

Contains: Map of Placer County, scale 1″ = 3 mi.

*10. Register of mines and minerals, Shasta County, California, by M. E. Dittmar. 1902. 15 pp., 1 map.

Contains: Map of Shasta County, scale 1″ = 3 mi.

*11. Register of mines and minerals, San Bernardino County, California, by G. E. Bailey. 1902. 20 pp., 3 maps.

Contains: Map of San Bernardino County, scale 1″ = 6 mi.; Map of the mountains of the Mojave Desert, San Bernardino County, p. 3; Map of desert fissure springs, San Bernardino County, by R. P. McLaughlin, p. 4.

*12. Register of mines and minerals. Amador County, California, by John B. Tregloan. 1903. 13 pp., 2 maps.

Contains: Map of Amador County, scale 1″ = 1½ mi.; Economic geological map of the western half of Amador County, compiled from the maps of the U. S. Geological Survey, p. 2.

*13. Register of oil wells, Los Angeles City, Los Angeles County, California, by Charles A. Blackmar. 1903. 13 pp., 1 map.

Contains: Map of Los Angeles City oil fields.

*14. Register of mines and minerals, San Diego County, California, by Irving A. Hubon. 1903. 11 pp., 1 map.

Contains: Map of San Diego County, scale 1″ = 5 mi.

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*15. Register of mines and minerals, Sierra County, California, by George F. Taylor. 1903. 14 pp., 2 maps.

Contains: Map of Sierra County, scale 1″ = 1½ mi.; Economic geological map of the western half of Sierra County, compiled from the maps of the U. S. Geological Survey, p. 1.

*16. Register of mines and minerals, Tuolumne County, California, by R. P. McLaughlin. 1903. 16 pp., 2 maps.

Contains: Map of Tuolumne County, scale 1″ = ½ mi. (approx.); Economic geological map of southwestern portion of Tuolumne County, compiled from the maps of the U. S. Geological Survey, p. 4.

*17. Register of mines and minerals, Butte County, California, by W. E. Thorne. 1904. 12 pp., 2 maps.

Contains: Map of Butte County, scale 1″ = 2 mi.; Map showing dredging lands adjacent to Feather River, Butte County, by O. W. Jasper, op. p. 4.

*18. Register of mines and minerals, Kern County, California, by Marion Aubury. 1904. 22 pp., 5 maps.

Contains: Map of Kern County, scale 1″ = 4 mi.; Kern River oil field, Kern County, by Paul W. Prutzman, p. 1; McKittrick oil field, Kern County, by Paul W. Prutzman, p. 2; Midway oil field, Kern County, by Paul W. Prutzman, p. 3; Sunset oil field, Kern County, by Paul W. Prutzman, p. 4.

*19. Register of mines and minerals, Mariposa County, California, by E. M. Wilkinson. 1904. 16 pp., 2 maps.

Contains: Map of Mariposa County, scale 1″ = 2½ mi.; Economic geological map of northwestern portion of Mariposa County, compiled from maps of U. S. Geological Survey.

*20. Register of mines and minerals, Santa Barbara County, California, by Lew B. Harris. 1906. 9 pp., 4 maps.

Contains: Map of Santa Barbara County, scale 1″ = 2 mi.; Summerland oil field, Santa Barbara County, p. 1; Santa Maria oil field, Santa Barbara County, by Lew B. Harris and J. A. Edman, p. 2; Los Alamos oil field, Santa Barbara County, by Lew B. Harris and J. A. Edman, p. 3.

*21. Register of mines and minerals, Yuba County, California, by Lew B. Harris. 1906. 14 pp., 3 maps.

Contains: Map of Yuba County, scale 1″ = 1½ mi.; Map showing dredging lands in the vicinity of Marysville, Yuba County, by Jason R. Meek, frontispiece; Economic geological map of Yuba County compiled from the maps of the U. S. Geological Survey, p. 2.

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REPORTS OF THE STATE MINERALOGIST (R)

*First Annual Report of the State Mineralogist, from June 1, 1880 to December 1, 1880; Henry G. Hanks, State Mineralogist. 43 pp.

Contains: Report, by Henry G. Hanks, p. 3; Report of progress—history, pp. 3-8; Minerals of the Pacific Coast, pp. 8-9; Donations to the museum and library, pp. 9-14; Report of the chemist, by Edward Booth, pp. 15-17; Statement of receipts and expenditures of the California State Mining Bureau, December 1, 1880, by Henry G. Hanks, p. 18; Account of the Mining Bureau fund, San Francisco—a memorandum, p. 18; Loan collections, pp. 19-22; Prospecting, pp. 22-25; Paper on the occurrence of electrum in California, pp. 25-26; Quicksilver, pp. 26-27; Iron, pp. 27-30; Salt, pp. 30-31; Tin, pp. 31-32; Chromic iron, p. 32; Building materials, pp. 32-36; Clay deposits of the state, pp. 36-38; Platinum, p. 38; Buhr millstone, p. 38; Low grade ores, pp. 38-39; Black sands from hydraulic and placer mines, pp. 39-41; Alkaline lakes, p. 41; Extensive metallurgical works required, pp. 41-42; Supply of coal, p. 42; Lithology, pp. 42-43; Ethnology, p. 43; State manufactures, p. 43.

*Second Report of the State Mineralogist of California, from December 1, 1880 to October 1, 1882; Henry G. Hanks, State Mineralogist. 1882. 288 pp., 1 map; Appendix, 226 pp.

Contains: Report, by Henry G. Hanks, pp. 5-15; Report of the secretary, pp. 16-27; Placer, hydraulic, and drift mining, pp. 28-192 (General remarks, pp. 28-43; Hydraulic mining, pp. 44-118; Drift mining, p. 119; Treatment, properties, history of gold, pp. 119-157; General geology, pp. 157-170; Gold production of California, pp. 171-192); Iron ores and iron industries of California, pp. 193-201; Lumber and fuel, pp. 202-216; On the occurrence of salt in California and its manufacture, pp. 217-226; Mud volcanoes and Colorado Desert, pp. 227-240, 1 map; Diamonds in California, pp. 241-254; Notes on mica, pp. 255-261; Notes on roscoelite, pp. 262-264; On the occurrence of vivianite in Los Angeles County, p. 265; Diatoms and diatomaceous earths, pp. 266-270; Contribution to the ethnology and geology of the Pacific slope, by Philip Harvey, pp. 271-279; Glossary of terms in common use among the miners of California, pp. 280-288. **Appendix, papers supplementary to the Report of the State Mineralogist:** Forest trees of California, by A. Kellogg, pp. 3-116; Notes on hydraulic mining, by F. W. Robinson, pp. 117-129; Hydraulic and drift mining, by Henry De Groot, pp. 130-190; On the milling of gold quartz, by Melville Attwood, pp. 191-203; Rare minerals recently found in the state, by William P. Blake, pp. 205-223; Flour gold, by Almarin B. Paul, pp. 224-226.

*Third Annual Report of the State Mineralogist for the year ending June 1, 1883; Henry G. Hanks, State Mineralogist. 1883. Part I, 26 pp. Part II, 111 pp., 1 map, 21 illus.

Contains: **Part I:** Report, by Henry G. Hanks, pp. 5-26: List of donors, pp. 6-7; Library, p. 7; Publications, pp. 7-8; Laboratory work, p. 8; Financial condition of the Mining Bureau, pp. 9-13; Consideration of the affairs of the State Mining Bureau, pp. 13-15; Pacific Coast Mining Exposition, pp. 15-16; Pacific Coast Mineral Exposition, pp. 16-17; The Honduras exhibit, pp. 17-18; Visitors, p. 18; Death of Joseph Wasson, p. 18; Anticipated removal, p. 19; Danger of fire, p. 19; State map, p. 19; Economic considerations, pp. 20-21; Microscope slides, pp. 21-22; Post offices to which circulars were sent asking for samples of soil, pp. 22-25; List of the most important economic minerals, pp. 25-26. **Part II:** Report on the borax deposits of California and Nevada, by Henry G. Hanks, pp. 1-102, 1 map, 21 illus.; Index, pp. 103-111.

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*Fourth Annual Report of the State Mineralogist for the year ending May 15, 1884; Henry G. Hanks, State Mineralogist. 1884. 410 pp., 8 illus.

Contains: Report, by Henry G. Hanks, pp. 5-27; Introduction, p. 5; Museum, p. 5; Publications, pp. 5-6; Library, p. 6; Visitors, p. 6; Donations, pp. 6-11; Statement of receipts and disbursements, State Mining Bureau, p. 11; Chemical work, pp. 11-14; Pacific Coast Mineral Exposition of August 1883, pp. 15-27. California—information, general and statistical in relation to the agricultural, commercial, manufacturing, and other resources, interests, and industries of the state, pp. 28-59: Resources of California, etc., pp. 31-37; Agriculture, pp. 37-42; Viticulture—grapes, wines, and raisins, pp. 43-45; Statistical summary, by Henry De Groot, pp. 45-50; Manufacturing, mechanical, and other leading industries, pp. 50-59. Catalogue and description of the minerals of California as far as known, with special reference to those having an economic value, pp. 61-397, 6 illus.: Introduction, pp. 63-66; California minerals, pp. 67-397, 6 illus. Index, pp. 399-410.

*Fifth Annual Report of the State Mineralogist, for the year ending May 15, 1885; Henry G. Hanks, State Mineralogist. 1885. 235 pp., 4 maps, 14 illus.

Contains: Report, by Henry G. Hanks, pp. 5-13; History of former World's Fairs or International Expositions, pp. 13-50, 7 illus. California, pp. 51-120: Geography, p. 51; Forests, p. 52; Scenery, p. 52; Climate, p. 53; Agricultural resources and products, pp. 53-54; History, pp. 54-58; California mineral exhibit in the government building, pp. 58-62; On hanksite, by William Earl Hidden, pp. 62-64, 2 illus.; Mineralogical notes —a large crystal of hanksite, by Edward S. Dana and Samuel L. Penfield (from American Journal of Science, Aug. 1885), pp. 65-66; (Catalogue of the special California minerals shown at the Exposition), pp. 66-73; Gold, pp. 73-78; A simple working test for determining the quality of gold mechanically combined with auriferous vein matter, by Melville Attwood, pp. 78-87, 3 illus.; Catalogue of California gold mines represented in the Exposition, pp. 87-91; Silver, pp. 92-94; Quicksilver, pp. 95-96; Copper, pp. 96-98; Iron, pp. 98-101; Lead and base bullion, p. 101; Chrome ores, pp. 101-102; Hydrocarbons and mineral fuels, pp. 102-105; Borax, pp. 105-106; Manganese, p. 106; Tin, p. 106; Cement, pp. 106-107; Antimony, p. 107; Rocks and building stones, pp. 107-119; Sundries exhibited but not classified, pp. 119-120; Sundry special exhibits, p. 120. Gold mines of Georgia and other mining localities in the South, pp. 120-127; Mineral exhibits made by other states and territories in the government building, pp. 128-227, 1 illus.; Errata, p. 228; Index, pp. 229-235.

*Sixth Annual Report of the State Mineralogist, for the year ending June 1, 1886; Henry G. Hanks and William Irelan Jr., State Mineralogists. 1887. Part I, 145 pp., 2 maps, 3 illus. Part II, 222 pp., 36 illus.

Issued also in separate parts, as indicated below.

* (a) **Part I, 145 pp., 2 maps, 3 illus., contains:** History of the State Mining Bureau, p. 5; Present condition of the State Mining Bureau, pp. 5-6; Donations, p. 6; Correspondence, pp. 6-7; Chemical work, p. 7; Library, p. 7; Visitors, p. 7; Publications, p. 7; Sacramento State collection of minerals, p. 7, State maps, pp. 7-8; Catalogue, p. 8; Origin of the name California, pp. 8-10; General condition of mining in California, pp. 10-11; Mining economics, pp. 11-12; Importance of gold and gold mining, pp. 12-14; Bimetalism, pp. 14-15; Difficulties attending manufacturing in California, pp. 15-16; Building stones and building materials in California, pp. 16-34; Table of altitudes, pp. 34-53; Water power, p. 54; Irrigation, pp. 54-55; Record of strata in artesian well, pp. 56-57; Mineral springs in

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California, pp. 58-76; Calistoga silver mines, pp. 76-77; Arrow mining district, San Bernardino County, pp. 77-78; Mount St. Helena, pp. 78-79, 2 illus.; San Diego County, pp. 80-90, 2 maps, 1 illus.; California minerals, pp. 91-141; Index, pp. 143-145.

*** (b) Part II, 222 pp., 36 illus., contains:** Report of the Trustees of the State Mining Bureau, pp. 5-12; Report, by Wm. Irelan Jr., pp. 14-15; Amador County, pp. 15-24; Butte County, pp. 24-27, 3 illus.; Calaveras County, pp. 27-42, 5 illus.; El Dorado County, pp. 42-43; Fresno County, pp. 43-44; Nevada County, pp. 44-52, 1 illus.; Sierra County, pp. 52-59; Tuolumne County, pp. 59-60; Tabular statement of mills, p. 61; Conclusion, p. 62; Bullion production of mines of California for 12 months ending January 1, 1886, p. 63; Number of incorporated companies, p. 64; U. S. Patents, p. 64; Hydraulic mines enjoined, p. 64; Wells, Fargo & Co.'s statistics, pp. 64-67; San Francisco Mint, pp. 67-68; Tables from report of Director of Mint, pp. 68-71; Table showing production of quicksilver in California for the year 1885, compiled by J. B. Randol, p. 72; Table showing production of quicksilver in California in the year 1886, compiled by J. B. Randol, p. 73; Hydromagnesite from Livermore, California, by F. Gutzkow, p. 74; Mine drainage, by Charles G. Yale, pp. 74-88, 3 illus.; Weight of quartz mills, pp. 88-90; Specifications for twenty-stamp gold mill, pp. 90-92; Concentration of gold and silver ores on the Pacific Coast, by J. M. Adams, pp. 92-116, 23 illus.; Golden Gate sulphuret concentrator, pp. 117-119, 1 illus.; Chlorination, by Wm. Irelan Jr., pp. 119-122; Mineral products of the United States, 1885, pp. 123-127; Summary of the mineral products of the U. S., cal. yrs. 1882-1885, pp. 128-131; U. S. mining laws, pp. 132-175; To find the value of gold or silver of a specimen, by C. H. Aaron, pp. 176-177; Tables taken from "Practical Hydraulics," by P. M. Randall, pp. 178-182; Chapter IV, Part II, Title III, Political code of the State of California, pp. 183-189; Routes of travel, modes of conveyance, distances, etc., from San Francisco, pp. 190-214; Index, pp. 215-222.

*Seventh Annual Report of the State Mineralogist, for the year ending October 1, 1887; William Irelan Jr., State Mineralogist. 1888. 315 pp., 12 illus.

Contains: Report of Trustees of State Mining Bureau, pp. 5-8; Report, by Wm. Irelan Jr., p. 10; Origin of petroleum, pp. 10-11; Petroleum fields of California, pp. 11-16; Petroleum deposits in Venezuela, p. 16; Petroleum deposits in the Argentine Republic, pp. 16-17; Petroleum, where found, p. 17; Petroleum in Russia, pp. 17-23; Petroleum as a fuel, pp. 23-33, 3 illus.; Refining, pp. 34-37, 1 illus.; Chemistry of petroleum, pp. 37-41, 1 illus.; Locating for drilling, etc., pp. 41-47; Petroleum produced in and exported from the United States, 1864-1886 (from the Statistical Abstract of the United States, 1886), p. 48; Locating and patenting petroleum claims, pp. 49-50; Asphaltum and its uses, pp. 50-51; Laying of asphaltum on public thoroughfares, p. 51; Results of analyses of California asphaltum, pp. 51-53; Locating and patenting asphaltum claims, pp. 54-55; Natural gas in the Eastern states, pp. 55-56; Value of gas as a fuel, p. 56; Coal-land law and regulations thereunder, pp. 57-61; Petroleum, asphaltum, and natural gas in California, by W. A. Goodyear, pp. 65-114, 3 illus.; Coal in California, by W. A. Goodyear, pp. 117-178, 1 illus.; Natural gas in California, by Adolph H. Weber, pp. 181-191; Petroleum and asphaltum in northern California, by Adolph H. Weber, pp. 195-202, 3 illus.; Building stones, by A. Wendell Jackson, pp. 205-213; Precious metals product, United States of America and Mexico, report of Wells, Fargo & Co., pp. 217-219; Catalogue of Californian fossils, by J. G. Cooper, pp. 223-308; Index, pp. 309-315.

*Eighth Annual Report of the State Mineralogist for the year ending October 1, 1888; William Irelan Jr., State Mineralogist. 1888. 948 pp., 10 pls., 1 map, 106 illus.

Contains: Report of Trustees of State Mining Bureau, pp. 7-10, 2 illus.; California, pp. 12-16, 1 illus.; The Mining Bureau, pp. 16-22.

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Mineral resources of state, pp. 22-691: Alameda County, pp. 25-36, 4 illus.; Alpine County, pp. 36-40; Amador County, pp. 41-115, 12 illus.; Butte County, pp. 116-121; Calaveras County, pp. 121-157, 3 illus.; Colusa County, pp. 157-159; Contra Costa County, pp. 159-163; Del Norte County, pp. 163-164; El Dorado County, pp. 164-202; Fresno County, pp. 202-216; Humboldt County, pp. 216-223; Inyo County, by W. A. Goodyear, pp. 224-309, 15 illus. (including Owens Valley earthquake, pp. 288-309); Kern County, by W. A. Goodyear, pp. 309-324, 2 illus.; Lake County, pp. 324-329; Lassen County, pp. 329-332; Los Angeles County, pp. 332-335; Los Angeles County, by W. A. Goodyear, pp. 335-342; Marin County, p. 342; Mariposa County, pp. 343-349; Mendocino County, p. 349; Merced County, pp. 350-351; Modoc County, p. 352; Mono County, by H. A. Whiting, pp. 352-401, pls. 2-3, 1 illus.; Monterey County, pp. 402-411; Napa County, pp. 411-417; Nevada County, pp. 417-459, 1 illus.; Placer County, pp. 459-476; Plumas County, pp. 476-483; San Benito County, pp. 483-490; San Bernardino County, pp. 490-504; San Bernardino County, by W. A. Goodyear, pp. 504-512; San Diego County, pp. 512-516; San Diego County, by W. A. Goodyear, pp. 516-528; San Francisco County, pp. 528-529; San Luis Obispo County, pp. 529-533; San Mateo County, pp. 533-536; Santa Barbara County, pp. 536-540; Santa Clara County, pp. 540-550, 3 illus.; Santa Cruz County, pp. 550-556; Sacramento County, pp. 556-557; San Joaquin County, pp. 557-562; Shasta County, pp. 562-572; Sierra County, pp. 573-581; Siskiyou County, pp. 581-631; Solano County, pp. 631-632; Sonoma County, pp. 632-635; Stanislaus County, pp. 635-636; Sutter County, pp. 636-637; Tehama County, p. 637; Trinity County, pp. 637-643; Tulare County, by W. A. Goodyear, pp. 643-652; Tuolumne County, pp. 652-672, 1 illus.; Ventura County, pp. 676-678; Ventura County, by Stephen Bowers, pp. 679-690; Yolo County, p. 690; Yuba County, p. 691. Tabular statement of mills, arranged by counties, pp. 692-695; The milling of gold ores in California, by John Hays Hammond, pp. 696-735, 40 illus.; Drift mining in California, by Russell L. Dunn, pp. 736-770; Lithology of wall rocks, by Melville Attwood, pp. 771-784, 1 map, 9 illus.; Water wheels, by F. F. Thomas, pp. 785-803, 10 illus.; Notes on western lead smelting, by W. S. Keyes, pp. 804-831, pls. 1-6, 8-9; The Russell process, pp. 832-835; Notes on the hydrometallurgy of gold, by C. H. Aaron, pp. 836-846; Notes on the hydrometallurgy of silver, by C. H. Aaron, pp. 847-864; Natural and artificial cement, pp. 865-884, 1 illus.; Building stones, by A. Wendell Jackson, pp. 885-894; United States patents in California, pp. 895-896; Water rights, p. 897; The Alien Act, amendment of, p. 898; Imports of minerals and mineral products, pp. 898-899; Index, pp. 901-948.

*Ninth Annual Report of the State Mineralogist, for the year ending December 1, 1889; William Irelan Jr., State Mineralogist. 1890. 352 pp., 8 pls., 51 illus.

Contains: Report of Trustees of State Mining Bureau, pp. 7-11; Report, by Wm. Irelan Jr., pp. 15-19; California's variety and distribution of mineral wealth, pp. 19-20; Mining barely begun in California, p. 20; Debasing the bullion, pp. 20-21; Number of men engaged in mining, pp. 21-23; The Mongolian element, p. 23; The California miner, pp. 23-24; More common minerals and metals, p. 24; Quartz mining, p. 24; Number of quartz mills, stamps, drops, duty, etc., pp. 24-25; Cost of mining and milling ore—value and percentage of sulphurets, etc., p. 25; Our argentiferous ores, pp. 25-26; Hydraulic mining, 26; Booming, 26-27; Drift operations, pp. 27-29; River-bed mining—how carried on in California, pp. 29-30; The Big Bend tunnel, pp. 30-31; The northern tier of counties, pp. 31-32; The future of silver and its effects on California, pp. 32-35; Our gold bluffs and beaches, pp. 35-36; The dry and the seam diggings, the cement, pocket, and tailings deposits, nugget mining, crevicing, etc., pp. 36-38; Recovering auriferous gravel from sea beaches and river beds by means of dredges, submarine armor, and other apparatus, pp. 38-39; What has been attempted

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in other countries, pp. 39-40; Letter to the State Mineralogist, by Harry I. Willey, pp. 40-45; Letter to the State Mineralogist, by Ross E. Browne, pp. 45-46; Santa Clara County, by A. H. Weber, pp. 48-56; San Nicolas Island, by Stephen Bowers, pp. 57-61; Refining and coining of the precious metals, by Sven Gumbinner, pp. 62-104; The auriferous gravels of California, by John Hays Hammond, pp. 105-138, pls. 1-8, 20 illus.; San Diego County, by W. A. Goodyear, pp. 139-154; Santa Cruz Island, by W. A. Goodyear, pp. 155-170, 1 illus.; Stray notes on the geology of the Channel Islands, by Lorenzo G. Yates, pp. 171-174, 2 illus.; The mollusca of the Channel Islands of California, by Lorenzo G. Yates, pp. 175-178, 2 illus.; Insular floras, by Lorenzo G. Yates, pp. 179-188; 1 illus.; Los Angeles County, by E. B. Preston, pp. 189-210, 6 illus.; Lassen County, by E. B. Preston, pp. 211-213; San Bernardino County, by James H. Crossman, pp. 214-239; Pottery, by Linna Irelan, pp. 240-261, 5 illus.; River mining, by R. L. Dunn, pp. 262-281, 9 illus.; Slate quarrying in California, pp. 282-283; The value of fossils as indications of important mineral products, by J. G. Cooper, pp. 284-286; Clays, by W. D. Johnston, pp. 287-308, 5 illus.; California cement, pp. 309-311; Meteorological, by George E. Barnes, pp. 312-322; Coal product of California, p. 323; The manufacture of glass in California, by Henry De Groot, pp. 324-329; Mineral products of the United States in 1888, pp. 330-339; Index, pp. 341-352.

* Tenth Annual Report of the State Mineralogist for the year ending December 1, 1890; William Irelan Jr., State Mineralogist. 1890. 983 pp., 14 maps, 153 illus.

Contains: Report of the Trustees of State Mining Bureau, pp. 7-10; Report, by William Irelan Jr., pp. 13-22; Geology of the Mother Lode region, by Harold W. Fairbanks, pp. 23-90, 1 map, 31 figs.; Alameda County, by W. A. Goodyear, pp. 91-95; Alpine County, by Henry De Groot, pp. 96-97; Amador County, by J. A. Brown, pp. 98-123; Butte County, by J. A. Miner, pp. 124-146; Calaveras County, by J. A. Brown, pp. 147-152; Colusa County, by W. A. Goodyear, pp. 153-164; Contra Costa County, by W. A. Goodyear, p. 165; Del Norte County, by Alexander McGregor, pp. 166-168; El Dorado County, by Henry De Groot, pp. 169-182; Fresno County, by L. P. Goldstone, pp. 183-204, 1 map, 7 illus.; Humboldt County, by Alexander McGregor, pp. 205-208; Inyo County, by Henry De Groot, pp. 209-218; Kern County, by Myron Angel, pp. 219-226; Lake County, by W. A. Goodyear, pp. 227-271; Lassen County, by E. B. Preston, pp. 272-276; Los Angeles County, by E. B. Preston, pp. 277-283, 1 illus.; The Pico Cañon oil field, by Edward North, pp. 283-298, pls. 1-12, 1 map; Marin County, by W. A. Goodyear, p. 299; Mariposa County, by E. B. Preston, pp. 300-310, 1 illus,; Mendocino County, by Alexander McGregor, pp. 311-314; Mendocino County, by W. A. Goodyear, pp. 314-322; Merced County, by W. L. Watts, pp. 323-331; Modoc County, by E. B. Preston, pp. 332-335; Mono County, by Henry De Groot, pp. 336-344; Monterey County, by Myron Angel, pp. 345-348; Napa County, by W. A. Goodyear, pp. 349-363; Nevada County, by J. B. Hobson, pp. 364-398, 2 maps, 1 illus.; Orange County, by Stephen Bowers, pp. 399-409; Placer County, by J. B. Hobson, pp. 410-434, 6 maps, 6 illus.; The ancient river beds of the Forest Hill divide, by Ross E. Browne, pp. 435-465, 1 map, 16 illus.; Plumas County, by E. B. Preston, pp. 466-495, 4 illus.; Sacramento County, by W. L. Watts, pp. 496-514; San Benito County, by Myron Angel, pp. 515-517; San Bernardino County, its mountains, plains, and valleys, by Henry De Groot, pp. 518-539; San Diego County, by E. B. Preston, pp. 540-544, 1 illus.; The San Francisco ocean placer—the auriferous beach sands, by Henry De Groot, pp. 545-547; San Joaquin County, by W. L. Watts, pp. 548-566; San Luis Obispo County, by Myron Angel, pp. 567-585, 2 illus.; San Mateo County, by W. L. Watts, pp. 586-594; Santa Barbara County, by Myron Angel, pp. 595-599; The Santa Maria River, by J. B. Hobson, pp. 600-601, pls. 1-4; The gas well at Summerland, by F. H. Wheelan, pp. 601-603; Santa Clara County, by W. L. Watts, pp. 604-619; Santa Cruz County, by W. L. Watts, pp. 620-626, 1 illus.; Shasta County, by Alexander McGregor, pp. 627-641; Sierra County, by L. P. Goldstone, pp. 642-654, 1 map, 1 illus.; Siskiyou County, by J. B. Hobson, pp. 655-658; Solano County, by W. L. Watts, pp. 659-669; 1 illus.; Solano County, by W. A. Goodyear, pp. 669-671; Sonoma County, by W. A. Goodyear, pp. 672-679; Stanislaus County, by W. L. Watts, pp. 680-690; Sutter County, by E. B. Preston, p. 691; Tehama County, by E. B. Preston, pp. 692-694, 1 illus.; Trinity County, by Wm. P. Miller, pp. 695-727, pls. 1-8, 1 map; Tulare County, by Myron Angel, pp. 728-733; Tuolumne County, by L. P. Goldstone, pp. 734-757, 3 illus.; Ventura County, by Stephen Bowers, pp. 758-772; Report on the asphaltum mine of the Ventura Asphalt Company, by E. W. Hilgard, pp. 763-772, 2 illus.; Yolo County, by W. L. Watts, pp. 773-793; Yolo County, by W. A. Goodyear, pp. 793-794; Altitudes of various points northwest of San Francisco, p. 794; Yuba County, by E. B. Preston, pp. 795-802; Lead smelting, by F. C. von Petersdorff, pp. 803-851, 44 illus.; Mining of gold ores in California, by John Hays Hammond, pp. 852-882; Location of mines, by R. P. Hammond Jr., pp. 883-896, 6 illus.; The introduction of producer-gas at the Marsac mill, Park City, Utah, by C. A. Stetefeldt, pp. 897-898; The Colorado Desert, by Charles Russell Orcutt, pp. 899-919; Quicksilver mines and reduction works, by J. B. Randol, pp. 920-929; Mineral lands within the railroad grant, Eagle Bird mine, Nevada County, pp. 930-937; Gold extraction by potassium cyanide, by Wm. D. Johnston, pp. 938-942; Rincon Hill well, pp. 943-945; Meteorites, by F. C. von Petersdorff, pp. 946-951; Index, pp. 953-983.

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The following are included with report: Geological map of the Mother Lode region, scale 1″ = 1 mi. (re-issued 1896); Map of the Forest Hill divide, Placer County, California, scale 1″ = 2000 ft.; Geological map of the Iowa Hill mining district, Placer County, scale 2″ = 3000 ft., accompanied by cross-section plates, and longitudinal-section plates; Geological map of Trinity County, California, scale 1″ = 6 mi. (approx.).

*Eleventh Report of the State Mineralogist (first biennial) two years ending September 15, 1892; William Irelan Jr., State Mineralogist. 1893. 612 pp., 4 maps, 73 illus. Price $1.50 (damaged copies only).

Contains: Editor's report to the Board of Examiners, by Charles G. Yale, pp. 3-7; Report of Trustees of State Mining Bureau, pp. 11-15; Report, by William Irelan Jr., pp. 18-20; Hydraulic mining, p. 20; Drift mining, p. 20; River-bed mining, pp. 20-21; Vein mining, p. 21; Are the mines worked out?, p. 21; Silver mines, p. 22; Geological synopsis, pp. 22-23; Geology and mineralogy of Shasta County, by Harold W. Fairbanks, pp. 24-53, 1 map, 5 illus.; Notes on the geology and mineralogy of portions of Tehama, Colusa, Lake, and Napa Counties, by Harold W. Fairbanks, pp. 54-75, 3 illus.; Geology of San Diego County; also of portions of Orange and San Bernardino Counties, by Harold W. Fairbanks, pp. 76-120, 1 map, 8 illus.; Alameda County, by W. L. Watts, pp. 121-138; Amador County, by E. B. Preston, pp. 139-149; Butte County, by E. B. Preston, pp. 150-166, 1 map, 18 illus.; Calaveras County, by E. B. Preston, pp. 167-178; Colusa County, by W. L. Watts, pp. 179-188, 1 illus.; Contra Costa County, by W. L. Watts, pp. 189-194; Del Norte County, by W. L. Watts, pp. 195-199; El Dorado County, by E. B. Preston, pp. 200-209, 1 map, 3 illus.; Fresno County, by W. L. Watts, pp. 210-223, 5 illus.; Glenn County, by W. L. Watts, pp. 224-226; Humboldt County, by W. L. Watts, pp. 227-232, 2 illus.; Kern County, by W. L. Watts, pp. 233-238, 1 illus.; Lake County, by W. L. Watts, pp. 239-240; Lassen County, by E. B. Preston, pp. 241-242, 1 illus.; Los Angeles County, by W. H. Storms, pp. 243-248, 1 illus.; Marin County, by W. L. Watts, pp. 249-254; Mendocino County, by W. L. Watts, pp. 255-256; Merced County, by W. L. Watts, pp. 257-258; Monterey County, by E. B. Preston, pp. 259-262, 1 illus.; Nevada County, by J. B. Hobson and E. A. Wiltsee, pp. 263-318;

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Placer County, by W. L. Watts, pp. 319-322; Plumas County, by E. B. Preston, pp. 323-333, 1 illus.; Sacramento County, by W. L. Watts, pp. 334-336; San Bernardino County, by W. H. Storms, pp. 337-369, 11 illus.; San Benito County, by E. B. Preston, pp. 370-373; Santa Clara County, by W. L. Watts, pp. 374-375; San Diego County, by W. H. Storms, pp. 376-393, 7 illus.; San Joaquin County, by W. L. Watts, p. 394; Shasta County, by Wm. G. Hodson, pp. 395-399; Sierra County, by E. B. Preston, pp. 400-419, 3 illus.; Siskiyou County, by R. L. Dunn, pp. 420-452; Sonoma County, by W. L. Watts, pp. 453-463; Stanislaus County, by W. L. Watts, pp. 464-468; Sutter County, by W. L. Watts, pp. 469-471; Tehama County, by W. L. Watts, pp. 472-479; Trinity County, by R. L. Dunn, pp. 480-484; Tulare County, by W. L. Watts, pp. 485-492; Tuolumne County, by E. B. Preston, pp. 493-513, 3 illus.; Yolo County, p. 514; Yuba County, by W. L. Watts, pp. 515-516; Hydraulic ejectors, by E. A. Wiltsee, pp. 517-520, 1 illus.; A dissertation upon the origin, development, and establishment of American mining law, by A. H. Ricketts, pp. 521-574, with index, pp. 608-609; Index pp. 575-612.

The following are included with the report: Geological map of Shasta County, scale 1″ = 4 mi., approx.; Geological map of portions of San Diego, Orange, and San Bernardino Counties, scale 1″ = 6 mi.

*Twelfth Report of the State Mineralogist (second biennial) two years ending September 15, 1894; J. J. Crawford, State Mineralogist. 1894. 541 pp., 10 pls., 4 maps, 98 illus.

Contains: Report of Trustees of State Mining Bureau, pp. 3-7; To the Trustees of the State Mining Bureau, by J. J. Crawford, pp. 8-20; Antimony, pp. 21-23; Argentiferous galena, pp. 23-26; Asphaltum and bituminous rock, pp. 26-33; Borax, pp. 34-35, 2 illus.; Chromic iron, pp. 35-38; Coal, pp. 38-65, 9 illus.; Copper, pp. 66-70; Gold, pp. 70-322 (includes Geology of a portion of Madera and Mariposa Counties, by W. H. Storms, pp. 165-176), 1 map, 27 illus.; Gypsum, pp. 323-325; Iron, pp. 325-327; Magnesite, p. 328; Manganese, pp. 329-330; Mineral springs, pp. 331-347; Natural gas, pp. 348-352; Petroleum, pp. 352-358; Quicksilver, pp. 358-372; Silver, pp. 372-378, 2 illus.; Structural materials, pp. 379-405, 7 illus.; Miscellaneous, pp. 406-411, 1 illus.; Method of determining the respective quantities of gold and quartz in quartz specimens, p. 412; Electric power transmission plants and the use of electricity in mining operations, by Thomas Haight Leggett, pp. 413-455, pls. 1-10, 18 illus.; Red Rock, Goler, and Summit mining districts, in Kern County, by Harold W. Fairbanks, pp. 456-458, 4 illus.; Auriferous conglomerate in California, by R. L. Dunn, pp. 459-471, 1 map; Preliminary report on the mineral deposits of Inyo, Mono, and Alpine Counties, by Harold W. Fairbanks, pp. 472-478, 2 illus.; Geology of a section of El Dorado County, by Harold W. Fairbanks, pp. 479-481; Ancient channel system of Calaveras County, by W. H. Storms, pp. 482-492, 2 maps, 7 illus.; Geology of northern Ventura, Santa Barbara, San Luis Obispo, Monterey, and San Benito Counties, by Harold W. Fairbanks, pp. 493-526, 18 illus.; Appendix, pp. 529-541 (including State Mining Bureau Act, pp. 529-532; Act establishing a system of mine bell signals, pp. 532-533; Act defining hydraulic mining, p. 534; Debris Commission Act, pp. 534-535; The Caminetti Law, pp. 535-541).

The following are included with the report: Map of auriferous conglomerate deposit, Siskiyou County, California, scale 1″ = 1 mi. Map showing ancient channel system of Calaveras County, scale ⅜″ = 1 mi., approx.; and The ancient channel system between San Andreas and Mokelumne Hill, scale 1⅜″ = 1 mi.

*Thirteenth Report (third biennial) of the State Mineralogist for the two years ending September 15, 1896; J. J. Crawford, State Mineralogist. 1896. 726 pp., 1 map, 94 illus.

Contains: Report of Trustees of State Mining Bureau, pp. 3-9; To the Trustees of the State Mining Bureau, by J. J. Crawford, pp. 10-30

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(includes Quartz and drift mining, pp. 10-14; Hydraulic mining, pp. 14-18; Product of precious metals, p. 18; Petroleum, p. 19; Tin, p. 19; Reports, pp. 19-20; Appropriations, p. 20; Bureau fund, p. 20; County resources, p. 20; Geological Survey, pp. 21-23; Hydrography, p. 23; Department of Mines, pp. 23-24; Official visits, p. 24; Bulletins, pp. 24-27; Miscellaneous papers, pp. 27-28; California Miners' Association, pp. 28-29; Field assistants, pp. 29-30). Antimony, p. 31; Argentiferous galena, pp. 32-34; Asphalt and bituminous rock, pp. 35-45, 4 illus.; Borax, pp. 46-47; Chromic iron, pp. 48-50, 2 illus.; Coal, pp. 51-56; Copper, pp. 57-64, 1 illus.; Gold, pp. 64-503, 1 map, 29 illus.; Gypsum, pp. 503-504; Iron, p. 504; Magnesite, p. 505; Manganese, pp. 506-507; Mineral springs, pp. 508-524; Mining and irrigation ditches, artesian wells, etc., pp. 525-566, 3 illus.; Natural gas, pp. 567-569; Petroleum, pp. 570-593, 3 illus.; Quicksilver, pp. 594-604, 6 illus.; Silver, pp. 605-611; Structural materials, pp. 612-641, 7 illus.; Miscellaneous, pp. 642-646, 2 illus.; Appendix, pp. 647-726 (includes Preservation of structural timber, by John D. Isaacs, pp. 647-655, 1 illus.; Resumé of original researches, analyses, and refining methods of petroleum mainly from the southern counties of California, by Frederick Salathe, pp. 656-661; Oil as fuel in Los Angeles County, by W. L. Watts, pp. 662-664; Ore-deposits with special reference to the Mother Lode, by Harold W. Fairbanks, pp. 665-672; Electric-power transmission plants in California, by W. F. C. Hasson, pp. 673-678, 18 illus.; The sampling and measurement of ore-bodies in mine examinations, by Edmund B. Kirby, pp. 679-700, 13 illus.; Comstock ore-sampling, by John D. McGillivray, pp. 701-705; A water-power and compressed-air transmission plant for the North Star Mining Company, Grass Valley, California, by Arthur De Wint Foote, pp. 706-720, 4 illus.; The coming motive power, by Joseph W. Buell, from "Inventive Age." pp. 721-725; Congressional Act, making appropriations for the construction, repair, and preservation of certain public works on rivers and harbors, and for other purposes, p. 726, 36 illus.)

*Fourteenth Report of the State Mineralogist (biennial period 1913-14); Fletcher Hamilton, State Mineralogist. 1916. 974 pp., 275 illus.

Issued also in separate parts, as indicated below.

* (a) **Part 1,** The counties of Amador, Calaveras, and Tuolumne, by W. B. Tucker. pp. 1-172, 54 illus.

(b) **Part 2,** The counties of Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma, Yolo, by Walter W. Bradley, pp. 173-370, 71 illus. Price 50¢.

* (c) **Part 3,** The counties of Del Norte, Humboldt, Mendocino, by F. L. Lowell, pp. 371-425, 16 illus.

* (d) **Part 4,** The counties of Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin, Stanislaus, by Walter W. Bradley, G. Chester Brown, F. L. Lowell, R. P. McLaughlin, pp. 427-634, 80 illus.

* (e) **Part 5,** The counties of San Diego, Imperial, by Frederick J. H. Merrill, pp. 635-743, 32 illus.

* (f) **Part 6,** The counties of Shasta, Siskiyou, Trinity, by G. Chester Brown, pp. 745-925, 22 illus.; Index, pp. 929-974.

* Fifteenth Report of the State Mineralogist (biennial period 1915-16); Fletcher Hamilton, State Mineralogist. 1919. 990 pp., 15 pls., 3 maps, 398 illus.

Issued also in separate parts, as indicated below.

* (a) **Part 1,** Alpine County, Inyo County, Mono County, by Arthur S. Eakle, Emile Huguenin, R. P. McLaughlin, and Clarence A. Waring, pp. 1-175, 8 pls., 110 illus.

(b) **Part 2,** The counties of Butte, Lassen, Modoc, Sutter, and Tehama, by W. B. Tucker and Clarence A. Waring, pp. 179-266, 24 illus. Price 50¢.

* (c) **Part 3,** The counties of El Dorado, Placer, Sacramento, Yuba, by W. B. Tucker and Clarence A. Waring, pp. 267-459, 1 map, 81 illus.

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* (d) **Part 4,** Los Angeles County, Orange County, Riverside County, by Frederick J. H. Merrill, pp. 461-589, 34 illus.

* (e) **Part 5,** The counties of Monterey, San Benito, San Luis Obispo, Santa Barbara, Ventura, by Walter W. Bradley, Emile Huguenin, C. A. Logan, and Clarence A. Waring, pp. 590-769, 3 pls., 61 illus.

* (f) **Part 6,** San Bernardino County, Tulare County, by H. C. Cloudman, Emile Huguenin, F. J. H. Merrill, and W. B. Tucker, pp. 771-954, 4 pls., 1 map, 79 illus.

Index, pp. 959-990.

* Sixteenth Report of the State Mineralogist; Fletcher Hamilton, State Mineralogist. 1920. 270 pp., 188 pp., 144 pp.; 40 illus., 12 illus., 21 illus.

Issued also in separate parts, as indicated below.

* (a) Mines and mineral resources of Nevada County, by Errol MacBoyle [December 1918] 1919, 270 pp., 40 illus.

(b) Mines and mineral resources of Plumas County, by Errol MacBoyle [December 1918] 1920, 188 pp., 12 illus. Price 50¢.

* (c) Mines and mineral resources of Sierra County, by Errol MacBoyle [December 1918] 1920, 144 pp., 21 illus.

Seventeenth Report of the State Mineralogist, 1920; Fletcher Hamilton, State Mineralogist. 1921. 562 pp., 8 pls., 62 illus. $2.50.

Mining in California during 1920. Contains: Introduction, by Fletcher Hamilton, pp. 3-4. *San Francisco field division*, by E. S. Boalich, pp. 5-261, pls. 1-3, 27 illus.: Part I, Scope of industry, pp. 7-16, Part II, San Francisco district by counties, pp. 17-562—Alameda County, by E. Huguenin and W. O. Castello, pp. 17-42, pl. 1, 2 illus.; Colusa County, pp. 43-47; Contra Costa County, by E. Huguenin and W. O. Castello, pp. 48-67, 6 illus.; Fresno County, pp. 68-73, 1 illus.; Glenn County, pp. 74-75; Kings County, pp. 76-77; Lake County, pp. 78-82; Madera County, pp. 83-84; Marin County, p. 85; Mariposa County, by W. O. Castello, pp. 86-143; Mendocino County, pp. 144-148; Merced County, pp. 149-150; Mono County, pp. 151-155; Monterey County, pp. 156-157; Napa County, pp. 158-161; Sacramento County, p. 161, San Benito County, p. 162; San Francisco County, by E. Huguenin and W. O. Castello, pp. 163-165; San Joaquin County, p. 166; San Mateo County, by E. Huguenin and W. O. Castello, pp. 167-179, 4 illus.; Santa Clara County, by E. Huguenin and W. O. Castello, pp. 180-227, pls. 2-3, 13 illus.; Santa Cruz County, by E. Huguenin and W. O. Castello, pp. 228-241, 1 illus.; Solano County, pp. 242-247; Sonoma County, pp. 248-252; Stanislaus County, pp. 253-255; Sutter County, p. 256; Tulare County, pp. 257-260; Yolo County, pp. 260-261. *Los Angeles field division*, by W. B. Tucker, pp. 263-390, pls. 4-8, 20 illus.: Part I, Scope of industry, pp. 264-266, Part II, Los Angeles district, by counties, pp. 267-390—Imperial County, pp. 267-272; Inyo County, pp. 273-305, pls. 4-5, 10 illus.; Kern County, pp. 306-316, 1 illus.; Los Angeles County, pp. 317-322; Orange County, p. 323; Riverside County, pp. 324-332, 3 illus.; San Bernardino County, pp. 333-374, pls. 6-8, 5 illus.; San Diego County, pp. 375-383; San Luis Obispo County, pp. 384-386, 1 illus.; Santa Barbara County, pp. 387-389; Ventura County, p. 390. *Auburn field division*, by C. A. Logan, pp. 391-490, 15 illus.: Part I, Introductory, pp. 393-396, Part II, Auburn district, by counties, pp. 397-490—Alpine County, pp. 399-405, 3 illus.; Amador County, pp. 406-414, 4 illus.; Butte County, pp. 415-418; Calaveras County, pp. 419-424; El Dorado County, pp. 425-433, 1 illus.; Nevada County, pp. 434-440; Placer County, pp. 441-454, 1 illus.; Plumas County, pp. 455-473, 3 illus.; Sierra County, pp. 474-478; Tuolumne County, pp. 479-489, 3 illus.; Yuba County, p. 490. *Redding field division*, by C. McK Laizure, pp. 491-544: Part I, Scope of industry, pp. 493-501, Part II, Redding district, by counties, pp. 502-544—Del Norte County, pp. 502-503; Humboldt County, pp. 504-506; Lassen County, pp. 507-511; Modoc County, pp. 512-513; Shasta County, pp. 514-528; Siskiyou County, pp. 529-536; Tehama County, p. 537; Trinity County, pp. 538-544; Index, pp. 545-562.

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* All publications marked with an asterisk (*) are out of print and cannot be obtained from the Division of Mines. Please do not send any money for publications so marked.

*Eighteenth Report of the State Mineralogist covering Mining in California and the activities of the State Mining Bureau during 1922; Fletcher Hamilton, State Mineralogist. 1923. 799 pp., 1 map, 72 illus.

Issued also in separate chapters, as indicated below.

*** (a) Chapter 1, January 1922, pp. 1-40.**

Contains: Redding field division, pp. 5-6; Auburn field division, by C. A. Logan, pp. 6-8; San Francisco field division, by C. McK Laizure, pp. 8-9; Los Angeles field division, by M. A. Newman, pp. 9-10; Oil and gas development, by R. E. Collom, p. 10; Placer gold resources, by Charles S. Haley, pp. 11-12; Non-metallic minerals of southern California, by M. A. Newman, pp. 13-14; Notes on the West Point district, Calaveras County, by C. A. Logan, pp. 15-21; Mining location on stock-raising lands, pp. 22-23; Statement to war minerals relief claimants, by Fletcher Hamilton, pp. 24-27.

*** (b) Chapter 2, February 1922, pp. 42-93, 33 illus.**

Contains: Shasta County, pp. 42-43; Trinity County, p. 43; by W. B. Tucker. El Dorado County, pp. 44-45; Nevada County, p. 45; Placer County, p. 45; by C. A. Logan. Contra Costa County, pp. 45-46; Napa County, p. 46; San Benito County, p. 46; San Mateo County, pp. 46-47; Tulare County, p. 47; by C. McK Laizure. Imperial County, pp. 47-48; Kern County, pp. 48-49; San Bernardino County, p. 49; San Diego County, p. 49; by M. A. Newman. Oil field development operations, by R. E. Collom, pp. 49-52; California's exhibit at the American Mining Congress Exposition, Chicago, Illinois, October 17-22, 1921, by Walter W. Bradley, pp. 54-58, 3 illus.; Genera of diatoms characteristic of marine and fresh waters, by G. Dallas Hanna and William M. Grant, pp. 59-76, 30 illus.; Change in mine assessment year, p. 77.

*** (c) Chapter 3, March 1922, pp. 96-204.**

Contains: Shasta County, p. 96; Siskiyou County, pp. 96-97; Trinity County, p. 97; by W. B. Tucker. Calaveras County, pp. 97-99; Tuolumne County, pp. 99-101; by C. A. Logan. Fresno County, pp. 101-102; Madera County, p. 102; Merced County, p. 102; Santa Clara County, pp. 102-103; Stanislaus County, p. 103; by C. McK Laizure. Imperial County, p. 104; Kern and San Bernardino Counties, pp. 104-106; by M. A. Newman. Oil field development operations, by R. E. Collom, pp. 106-108; Notes on iron ore occurrences in California, by E. S. Boalich, pp. 110-113; Economic minerals of the Avawatz Mountains, by W. B. Tucker, pp. 114-117, Agstone and its possibilities in California, by C. McK Laizure, pp. 118-121.

*** (d) Chapter 4, April 1922, pp. 138-204, 3 illus.**

Contains: Shasta County, pp. 138-139; Siskiyou County, p. 139; Trinity County, p. 139; by W. B. Tucker. Nevada County, pp. 139-143; Sierra County, p. 143; by C. A. Logan. Alameda County, pp. 143-144; Contra Costa County, p. 144; Mariposa County, pp. 144-145; San Benito County, 145-146, 1 illus.; San Francisco County, p. 146; by C. McK Laizure. Kern County, pp. 146-148; San Bernardino County, pp. 148-149; by M. A. Newman. Oil field development operations, by R. E. Collom, pp. 150-151; Bibliography of coal in California, by E. S. Boalich, pp. 152-157; The metallurgy of platinum, by Louis Duparc (reprint) pp. 158-172, 1 illus.

*** (e) Chapter 5, May 1922, pp. 206-254, 1 illus.**

Contains: Shasta County, pp. 206-207; Trinity County, p. 207; by W. B. Tucker. El Dorado County, pp. 208-210; Placer County, p. 211; by C. A. Logan. San Benito County, pp. 211-220, by E. S. Boalich. Kern County, pp. 220-221; Los Angeles County, p. 221; Riverside County, pp. 221-222; San Bernardino County, pp. 222-223; San Diego County, p. 223; by M. A. Newman. Oil field development operations, by R. E. Collom, pp. 224-225; Progress report on placer gold investigation, by Charles S. Haley, pp. 226-228; Memoranda on asphalt and bituminous sand deposits of

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California, by Lawrence Vander Leck, pp. 228-230; Non-metallic minerals of southern California [gypsum], by M. A. Newman, pp. 230-234; Mine assessment year, by C. McK Laizure, pp. 234-236, 1 illus.; Division of Minerals and Statistics, by Walter W. Bradley, pp. 239-245.

*** (f) Chapter 6, June 1922, pp. 256-294, 2 illus.**

Contains: Shasta County, pp. 256-257; Siskiyou County, p. 257; Trinity County, pp. 257-258; by W. B. Tucker. Butte County, pp. 258-261; Nevada County, p. 261; Placer County, pp. 261-263; by C. A. Logan. Contra Costa County, p. 263; Glenn County, pp. 263-264; by C. McK Laizure. Los Angeles and Riverside Counties, pp. 264-265; San Bernardino County, pp. 265-266; by M. A. Newman. Oil field development operations, by R. E. Collom, pp. 266-269; Gold lodes of the East Fork mining district, Trinity County, by W. B. Tucker, pp. 270-273; Proposed method of mining oil sands, by M. A. Newman, pp. 273-275; California minerals exhibited during Shrine Convention, by Walter W. Bradley, pp. 275-278; Division of Minerals and Statistics, by Walter W. Bradley, pp. 281-286.

(g) Chapter 7, July 1922, pp. 295-352, 5 illus. Price 30¢.

Contains: Del Norte County, p. 295; Modoc County, p. 295; Shasta County, pp. 295-297; Siskiyou County, p. 297; Trinity County, pp. 297-298; by W. B. Tucker. Amador County, pp. 298-301; El Dorado County, p. 301; Placer County, pp. 301-302; by C. A. Logan. Madera County, pp. 303-307, by C. McK Laizure. Kern County, pp. 307-308; San Bernardino County, pp. 308-312; by M. A. Newman. Oil field development operations, by R. E. Collom, pp. 311-312; Silver lodes of the South Fork mining district, Shasta County, by W. B. Tucker, pp. 313-321, 2 illus.; Dry placers of southern California, by Charles S. Haley, pp. 321-324; Division of Minerals and Statistics, by Walter W. Bradley, pp. 327-344, 3 illus.

(h) Chapter 8, August 1922, pp. 353-403, 1 illus. Price 30¢.

Contains: Modoc County, p. 353; Shasta County, pp. 353-354; Siskiyou County, pp. 354-355; Tehama County, p. 355; Trinity County, p. 355; by W. B. Tucker. Alpine County, pp. 355-363, by C. A. Logan. Mariposa County, pp. 363-366, by E. S. Boalich. Los Angeles County, pp. 366-368; San Bernardino County, pp. 368-370; by M. A. Newman. Oil field development operations, by R. E. Collom, pp. 370-372; Progress report on placer gold investigation, by Charles S. Haley, pp. 373-374; Valuation of mining and oil property, by Fletcher Hamilton, pp. 375-379; Division of Minerals and Statistics, by Walter W. Bradley, pp. 382-397, 1 illus.

(i) Chapter 9, September 1922, pp. 405-491, 6 illus. Price 30¢.

Contains: Shasta County, pp. 405-413, 1 illus., by W. B. Tucker. Mono County, pp. 413-419; Napa County, p. 419; by E. S. Boalich. Inyo County, pp. 419-421; Imperial County, p. 421; Los Angeles County, p. 422; San Bernardino County, pp. 422-424; San Luis Obispo County, p. 424; by M. A. Newman. Oil field development operations, by R. E. Collom, pp. 425-426; Division of Minerals and Statistics, by Walter W. Bradley, pp. 429-485, 5 illus.

(j) Chapter 10, October 1922, pp. 493-593, 13 illus. Price 30¢.

Contains: Shasta County, pp. 493-495; Siskiyou County, pp. 495-496; Tehama County, p. 496; Trinity County, pp. 496-499; by W. B. Tucker. Sierra County [Quartz mining in Alleghany district], pp. 499-519, 2 illus., by C. A. Logan. Tulare County, pp. 519-538, 7 illus., by C. McK Laizure. Inyo County, p. 539; Kern County, p. 539; San Bernardino County, pp. 539-542; by M. A. Newman. Oil field development operations, by R. E. Collom, pp. 543-544; Radioactivity in thermal gases at The Geysers, Sonoma County, California, by Walter W. Bradley, pp. 545-550, 4 illus.; Tertiary sluice robbers, by Charles S. Haley, pp. 550-553; China clay in California, Part I, by Thomas Normile, pp. 554-557; Division of Minerals and Statistics, by Walter W. Bradley, pp. 560-587.

*** (k) Chapter 11, November 1922, pp. 595-727, 1 map, 3 illus.**

Contains: Lassen County, p. 595; Shasta County, pp. 595-600, 1 illus.; Siskiyou County, p. 600; Trinity County, pp. 600-601; by W. B.

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Tucker. El Dorado County, p. 602; Placer County, pp. 602-603; Plumas County, pp. 604-606; Yuba County, pp. 606-608; by C. A. Logan. Napa County, pp. 608-610, 1 map, by C. McK Laizure. Inyo County, p. 611; San Bernardino County, pp. 611-614; by M. A. Newman. Oil field development operations, by R. E. Collom, pp. 615-617; California's mineral resources and the State Mining Bureau, by Fletcher Hamilton, pp. 618-627, 1 illus.; Division of Minerals and Statistics, by Walter W. Bradley, pp. 633-719.

(l) Chapter 12, December 1922, pp. 729-799, 4 illus. Price 30¢.

Contains: Shasta County, pp. 729-733, 2 illus.; Siskiyou County, p. 733; Trinity County, pp. 733-736, 1 illus.; by W. B. Tucker. Metal mining in the Auburn district, 1922, pp. 736-740, by C. A. Logan. Inyo County, pp. 740-741; Los Angeles County, p. 741; San Bernardino County, pp. 742-744; by M. A. Newman. Oil field development operations, by R. E. Collom, pp. 745-747; Ore treatment at the Belmont Shawmut mine, Tuolumne County, by C. A. Logan, pp. 748-750, 1 illus.; Bibliography of limestone deposits in California, by C. McK Laizure, pp. 751-754; Index, pp. 769-799.

*Nineteenth Report of the State Mineralogist covering Mining in California and the activities of the State Mining Bureau; Fletcher Hamilton, Lloyd L. Root, State Mineralogists. 1923. 258 pp., 29 illus.

Issued also in separate chapters, as indicated below.

***(a) Chapter 1, Mining in California, January 1923, pp. 1-52, i-x.**

Contains: Redding field division, by W. B. Tucker, pp. 7-13. Auburn field division, by C. A. Logan, pp. 13-21. San Francisco field division, by C. McK Laizure, pp. 21-29. Los Angeles field division, by M. A. Newman, pp. 29-33; Oil field development operations, by R. E. Collom, pp. 33-37; Primary and secondary gold concentrations, by Charles S. Haley, pp. 38-40.

(b) Chapter 2, Mining in California, February 1923, pp. 53-87, i-x, 1 illus. Price 30¢.

Contains: Redding field division, by W. B. Tucker, pp. 55-59. Mother Lode region, by C. A. Logan, pp. 59-60. Monterey County, by C. McK Laizure, p. 60. Kern County, p. 61; San Bernardino County, pp. 61-64; by M. A. Newman. Oil field development operations, by R. E. Collom, pp. 65-66; Mining location on stock-raising lands, pp. 67-68; Limestone deposits of McCloud River, Shasta County, and their possible value for cement material, by W. B. Tucker, pp. 69-71, 1 illus.; The problem of exploiting the small mine and prospect, by C. A. Logan, pp. 72-76.

(c) Chapter 3, Mining in California, March 1923, pp. 88-133, i-ix. Price 30¢.

Contains: Shasta County, pp. 89-93; Siskiyou County, p. 93; Tehama County, p. 93; Trinity County, p. 94; by W. B. Tucker. Amador County, pp. 94-97, by C. A. Logan. Kern County, pp. 97-98; Los Angeles County, p. 98; San Bernardino County, pp. 98-100; San Diego County, p. 100; by M. A. Newman. Oil field development operations, by R. E. Collom, pp. 101-102; Notes on peat and its occurrence in California, by C. McK Laizure, pp. 103-107.

(d) Chapter 4, Mining in California, September 1923, pp. 134-244, i-ix, 28 illus. Price 30¢.

Contains: Lassen County, p. 135; Shasta County, pp. 135-137; Siskiyou County, pp. 138-139; Trinity County, pp. 139-140; by W. B. Tucker. Nevada County, p. 140; Placer County, pp. 140-141; El Dorado County, pp. 141-143; Amador County, p. 143; Calaveras County, pp. 143-144; Tuolumne County, pp. 144-145; by C. A. Logan. Mendocino County, by C. McK Laizure, pp. 145-154, 3 illus. Imperial County, pp. 154-155; Kern County, pp. 155-164, 1 illus.; Los Angeles County, pp. 164-165; Orange County, p. 165; San Bernardino County, pp. 165-173, by W. B. Tucker. Oil field development operations, by R. E. Collom, pp. 174-184;

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Clay deposits of the Alberhill Coal and Clay Company, by James H. Hill, pp. 185-210, 19 illus.; Oil shale in Santa Barbara County, California, by F. D. Gore, pp. 211-224, 5 illus.; Agricultural Minerals Act, pp. 225-226. Index, pp. 247-258.

*Twentieth Report of the State Mineralogist covering Mining in California and the activities of the State Mining Bureau; Lloyd L. Root, State Mineralogist. 1924. 473 pp., 45 illus.

Issued also in separate chapters, as indicated below.

(a) Chapter 1, Mining in California, January 1924, pp. 1-72, i-ix, 10 illus. Price 30¢.

Contains: Amador County, pp. 1-3; Calaveras County, pp. 4-7; El Dorado County, pp. 8-9; Nevada County, pp. 9-12; Placer County, pp. 13-14; Plumas County, p. 14; Shasta County, pp. 15-17; Sierra County, pp. 17-18; Tuolumne County, pp. 19-23, 1 illus., by C. A. Logan. Metal mining, San Francisco field division, pp. 23-25; Non-metallic minerals, San Francisco field division, pp. 25-26; Napa County, pp. 26-28, 1 illus.; San Benito County, p. 28, 1 illus.; Santa Clara County, pp. 29-30, 1 illus.; Tulare County, pp. 30-33, by C. McK Laizure. Imperial County, p. 33; Inyo County, p. 33; Kern County, pp. 34-42, 1 map, 5 illus.; Los Angeles County, pp. 42-43; Orange County, pp. 43-45; Riverside County, pp. 45-46; San Bernardino County, pp. 46-49; San Diego County, pp. 49-50, by W. B. Tucker. Oil field development operations, by R. D. Bush, pp. 51-57.

(b) Chapter 2, Mining in California, April 1924, pp. 75-176, i-ix, 9 illus. Price 30¢.

Contains: Amador County, pp. 73-75; Calaveras County, pp. 76-80, 1 illus.; Mono County, p. 81; Placer County, pp. 81-82; Plumas County, pp. 82-83; Sacramento County, p. 83; Sierra County, p. 83; Yuba County, p. 84, by C. A. Logan. Contra Costa County, pp. 84-85; Lake County, p. 85; Mendocino County, pp. 86-87, 1 illus., by C. McK Laizure. Imperial County, pp. 87-91, 4 illus.; Los Angeles County, p. 91; San Bernardino County, pp. 92-97; Ventura County, pp. 97-98, by W. B. Tucker. Oil field development operations, by R. D. Bush, pp. 99-104; Oil and gas rights, by A. H. Ricketts, pp. 105-148; Note on andalusite from California, by Albert B. Peck, pp. 149-154, 1 illus.

***(c) Chapter 3, Mining in California, July 1924, pp. 177-353, i-ix, 12 illus.**

Contains: Amador County, pp. 177-178; Calaveras County, p. 178; El Dorado County, pp. 178-179; Nevada County, p. 179; Placer County, p. 179; Siskiyou County, pp. 179-183, by C. A. Logan. Alameda County, pp. 184-185, 1 illus., by C. McK Laizure. Inyo County, pp. 185-191, 3 illus.; Kern County, p. 191; Riverside County, pp. 191-196, 5 illus.; San Bernardino County, pp. 196-200, 3 illus., by W. B. Tucker. Oil field development operations, by R. D. Bush, pp. 201-207; Oil and gas rights, by A. H. Ricketts, pp. 208-245. Appendix: Regulations concerning oil and gas permits and leases, pp. 248-250; Oil and gas regulations, pp. 251-304; Notes on the law of mining locations and lands open to mining in California, by C. A. Logan, pp. 305-320; License required to handle mining property, by Edwin T. Keiser, pp. 321-322.

(d) Chapter 4, Mining in California, October 1924, pp. 355-473, 14 illus. Price 30¢.

Contains: Nevada County, pp. 355-362, 1 illus.; Sierra County, pp. 362-367, by C. A. Logan. Kern County, pp. 367-368; San Bernardino County, p. 368; San Diego County, pp. 368-374, by W. B. Tucker. Oil field development operations, by R. D. Bush, pp. 375-380; Oil and gas rights, by A. H. Ricketts, pp. 381-415; Mineral exhibit at American Mining Congress convention, at Sacramento, California, by Walter W. Bradley, pp. 416-418; Copper resources of Shasta County, by W. B. Tucker, pp. 419-447, 13 illus. Index, pp. 461-473.

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*Twenty-first Report of the State Mineralogist covering Mining in California and the activities of the State Mining Bureau; Lloyd L. Root, State Mineralogist. 1925. 624 pp., 3 pls., 4 maps, 109 illus.

Issued also in separate chapters, as indicated below.

*** (a) Chapter 1, Mining in California, January 1925, pp. 1-133, i-ix, 24 illus.**

Contains: Sacramento County, by C. A. Logan, pp. 1-22, 10 illus.; Monterey County, by C. McK Laizure, pp. 23-57, 9 illus.; Orange County, by W. B. Tucker, pp. 58-71, 5 illus.; Oil field development operations, by R. D. Bush, pp. 72-76; Mining law, by A. H. Ricketts, pp. 77-121.

*** (b) Chapter 2, Mining in California, April 1925, pp. 134-274, i-ix, 37 illus.**

Contains: Calaveras County, by C. A. Logan, pp. 135-172, 5 illus.; Merced County, by C. McK Laizure, pp. 173-183, 4 illus.; San Joaquin County, by C. McK Laizure, pp. 184-200, 8 illus.; Stanislaus County, by C. McK Laizure, pp. 200-222, 12 illus.; Ventura County, by W. B. Tucker, pp. 223-245, 8 illus.; Oil field development operations, by R. D. Bush, pp. 246-250; California foundry sands, pp. 251-257.

*** (c) Chapter 3, Mining in California, July 1925, pp. 275-411, i-ix, 3 pls., 2 maps, 27 illus.**

Contains: Ancient channels of the Duncan Canyon region, Placer County, by C. A. Logan, pp. 275-280, 1 map; Del Norte County, by C. McK Laizure, pp. 281-284; Humboldt County, by C. McK Laizure, pp. 295-324, pls. 1-3, 1 map, 9 illus.; San Diego County, by W. B. Tucker, pp. 325-382, 18 illus.; Oil field development operations, by R. D. Bush, pp. 383-389; Dealers in gold-silver ores and bullion must take out licenses, pp. 390-396.

*** (d) Chapter 4, Mining in California, October 1925, pp. 413-624, i-ix, 2 maps, 21 illus.**

Contains: Siskiyou County, by C. A. Logan, pp. 413-498, 11 illus.; San Luis Obispo County, by C. McK Laizure, pp. 499-538, 2 maps, 4 illus.; Santa Barbara County, by W. B. Tucker, pp. 539-562, 6 illus.; Oil field development operations, by R. D. Bush, pp. 563-567; Directory of California foundries, pp. 568-572; Index, pp. 597-624.

*Twenty-second Report of the State Mineralogist covering Mining in California and the activities of the State Mining Bureau; Lloyd L. Root, State Mineralogist. 1926. 610 pp., 5 maps, 129 illus.

Issued also in separate chapters, as indicated below.

*** (a) Chapter 1, Mining in California, January 1926, pp. 1-119, i-ix, 18 illus.**

Contains: Trinity County, by C. A. Logan, pp. 1-67, 10 illus.; Santa Cruz County, by C. McK Laizure, pp. 68-93, 8 illus.; Oil field development operations, by R. D. Bush, pp. 95-101; The so-called "mysterious white metal," by Frank Sanborn, pp. 102-107.

*** (b) Chapter 2, Mining in California, April 1926, pp. 120-312, i-ix, 4 maps, 47 illus.**

Contains: Shasta County, by C. A. Logan, pp. 120-216, 3 maps, 26 illus.; San Benito County, by C. McK Laizure, pp. 217-247, 7 illus.; Imperial County, by W. B. Tucker, pp. 248-285, 1 map, 14 illus.; Oil field development operations, by R. D. Bush, pp. 286-291; The Federal Revenue Act and the mining industry, pp. 292-297.

(c) Chapter 3, Mining in California, July 1926, pp. 313-396, i-ix, 1 map, 18 illus. Price 30¢.

Contains: Marin County, by C. McK Laizure, pp. 314-326, 5 illus.; Sonoma County, by C. McK Laizure, pp. 327-365, 1 map, 13 illus.; Oil field development operations, by R. D. Bush, pp. 366-369; Gas, gasoline, and petroleum, by A. H. Ricketts, pp. 370-372; Copper in California, by C. A. Logan, pp. 372-376.

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***(d) Chapter 4, Mining in California, October 1926, pp. 397-610, i-ix, 46 illus.**

Contains: El Dorado County, by C. A. Logan, pp. 397-452, 5 illus.; Inyo County, by W. B. Tucker, pp. 453-530, 23 illus.; Oil field development operations, by R. D. Bush, pp. 531-537; The Minarets district, Madera County, by Walter W. Bradley, pp. 539-557, 18 illus.; Index, pp. 573-610.

*Twenty-third Report of the State Mineralogist covering Mining in California and the activities of the State Mining Bureau; Lloyd L. Root, State Mineralogist. 1927. 456 pp., 1 map, 87 illus.

Issued also in separate chapters, as indicated below.

(a) Chapter 1, Mining in California, January 1927, pp. 1-130, i-ix, 1 map, 27 illus. Price 30¢.

Contains: Contra Costa County, by C. McK Laizure, pp. 2-31, 16 illus.; Mineral resources of Santa Catalina Island, by W. B. Tucker, pp. 32-39, 4 illus.; Oil field development operations, by R. D. Bush, pp. 40-43; Report of the Hydraulic Mining Commission upon the feasibility of the resumption of hydraulic mining in California, by Arthur Jarman, pp. 44-116, 1 map, 7 illus.

(b) Chapter 2, Mining in California, April 1927, pp. 131-234, i-ix, 24 illus. Price 30¢.

Contains: Amador County, by C. A. Logan, pp. 131-202, 20 illus.; Solano County, by C. McK Laizure, pp. 203-213, 4 illus.; Oil field development operations, by R. D. Bush, pp. 214-220; Manganese ore producers' committee, p. 221; Bibliography of clay deposits in California, pp. 221-222.

***(c) Chapter 3, Mining in California, July 1927, pp. 235-371, i-ix, 26 illus.**

Contains: Placer County, by C. A. Logan, pp. 235-286, 10 illus.; Los Angeles County, by W. B. Tucker, pp. 287-345, 16 illus.; Oil field development operations, by R. D. Bush, pp. 346-351; Ore Buyers' License Act, pp. 352-356.

(d) Chapter 4, Mining in California, October 1927, pp. 372-427, i-ix, 10 illus. Price 30¢.

Contains: Mono County, by W. B. Tucker, pp. 374-406, 10 illus.; Oil field development operations, by R. D. Bush, pp. 407-410; Department of Natural Resources Act, pp. 411-413; Index, pp. 429-456.

*Twenty-fourth Report of the State Mineralogist covering Mining in California and the activities of the State Mining Bureau; Lloyd L. Root, Walter W. Bradley, State Mineralogists. 1928. 405 pp., 2 maps, 59 illus.

Issued also in separate chapters, as indicated below.

(a) Chapter 1, Mining in California, January 1928, pp. 1-70, i-ix, 4 illus. Price 30¢.

Contains: Tuolumne County, by C. A. Logan, pp. 3-53, 4 illus; Oil field development operations, by R. D. Bush, pp. 54-59.

***(b) Chapter 2, Mining in California, April 1928, pp. 71-172, i-ix, 11 illus.**

Contains: Mariposa County, by C. McK Laizure, pp. 72-153, 2 maps, 11 illus.; Oil field development operations, by R. D. Bush, pp. 154-158.

***(c) Chapter 3, Mining in California, July 1928, pp. 173-260, i-ix, 6 illus.**

Contains: Butte County, by C. A. Logan, pp. 173-210, 4 illus.; Tehama County, by Charles V. Averill, pp. 211-216, 2 illus.; Oil field development operations, by R. D. Bush, pp. 217-221; Quartz crystals, pp.

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222-223; Notes on the law of mining locations and lands open to mining in California, by C. A. Logan, pp. 224-233; United States mining statutes, Title XXXII, Chapter 6, revised statutes, pp. 234-236; California statutes regarding location of mining claims, mill sites and assessment work, pp. 237-241.

(d) Chapter 4, Mining in California, October 1928, pp. 261-405, i-ix, 38 illus. Price 30¢.

Contains: Plumas County, by Charles V. Averill, pp. 261-316, 24 illus.; Madera County, by C. McK Laizure, pp. 317-345, 14 illus.; Oil field development operations, by R. D. Bush, pp. 346-352; Biennial report of the State Mineralogist, by Walter W. Bradley, pp. 354-360; Index, pp. 375-405.

*Twenty-fifth Report of the State Mineralogist covering Mining in California and the activities of the State Mining Bureau; Walter W. Bradley, State Mineralogist. 1929. 588 pp., 5 maps, 147 illus.

Issued also in separate chapters, as indicated below.

***(a) Chapter 1, Mining in California, January 1929, pp. 1-149, i-ix, 1 map, 61 illus.**

Contains: Lassen County, by Charles V. Averill, pp. 2-9, 5 illus.; Modoc County, by Charles V. Averill, pp. 10-19, 7 illus.; Kern County, by W. B. Tucker, pp. 20-81, 1 map, 15 illus.; Oil field development operations, by R. D. Bush, pp. 82-87; Mammoth tusks found near Oroville, California, by G. Dallas Hanna, pp. 88-90, 2 illus.; Mineral pigment tests, pp. 91-92; American Manganese Products Association, p. 93; Some special methods and machines for recovery of gold and platinum in placer deposits, by C. McK Laizure, pp. 94-135, 32 illus.

***(b) Chapter 2, Mining in California, April 1929, pp. 150-281, i-x, 3 maps, 19 illus.**

Contains: Sierra County, by C. A. Logan, pp. 151-212, 3 maps; Napa County, by Charles V. Averill, pp. 213-242, 14 illus.; San Francisco County, by C. McK Laizure, pp. 242-245; San Mateo County, by Sam P. Senior Jr., pp. 245-259, 5 illus.; Oil field development operations, by R. D. Bush, pp. 260-265.

(c) Chapter 3, Mining in California, July 1929, pp. 282-416, i-x, 28 illus. Price 30¢.

Contains: Colusa County, by C. A. Logan, pp. 284-300; Fresno County, by C. McK Laizure, pp. 301-336, 19 illus.; Lake County, by Charles V. Averill, pp. 337-365, 9 illus.; Oil field development operations, by R. D. Bush, pp. 366-371; Ore Buyers License Act, pp. 372-377; Assessment work on mining claim within withdrawn areas, by A. H. Ricketts, pp. 378-386; Surface rights of a mineral locator within the national forests, by A. H. Ricketts, pp. 387-390; "Mine" and "mineral" defined for Mining Bureau Act, p. 391; "Division of Mines" amendment, p. 392.

***(d) Chapter 4, Mining in California, October 1929, pp. 417-588, 1 map, 39 illus.**

Contains: Glenn County, by Charles V. Averill, pp. 418-426, 5 illus.; Alameda County, by C. McK Laizure, pp. 427-456, 13 illus.; Mendocino County, by Charles V. Averill, pp. 456-467, 3 illus.; Riverside County, by W. B. Tucker and R. J. Sampson, pp. 468-526, 1 map, 18 illus.; Oil field development operations, by R. D. Bush, pp. 527-532; Index, pp. 553-588.

*Twenty-sixth Report of the State Mineralogist covering activities of the Division of Mines including the Geologic Branch; Walter W. Bradley, State Mineralogist. 1930. 535 pp., 4 maps, 101 illus.

Issued also in separate chapters, as indicated below.

(a) Chapter 1, Mining in California, January 1930, pp. 1-88, i-ix, 25 illus. Price 40¢.

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Contains: Santa Clara County, by Herbert A. Franke, pp. 2-39, 13 illus.; Oil field development operations, by R. D. Bush, pp. 40-44; Barite in California, by Walter W. Bradley, pp. 45-57, 2 illus.; Mercury deposit in Coso Range, Inyo County, California, by Thor Warner, pp. 59-63, 4 illus.; Aerial photography and its importance to California geologists, by Leon T. Eliel, pp. 64-71, 6 illus.

***(b) Chapter 2, Mining in California, April 1930, pp. 89-183, i-ix, 2 maps, 5 illus.**

Contains: Nevada County, by C. A. Logan, pp. 90-137, 2 maps, 4 illus.; Geologic and economic mineral survey, by Olaf P. Jenkins, pp. 138-144; Oil field development operations, by R. D. Bush, pp. 145-147; Mineral paint materials in California, by Henry H. Symons, pp. 148-160, 1 illus.; Assessment work on mining claim within withdrawn areas, by A. H. Ricketts, pp. 161-163.

***(c) Chapter 3, Mining in California, July 1930, pp. 184-357, i-x, 2 maps, 35 illus.**

Contains: Yuba County, by C. A. Logan, pp. 186-201, 5 illus.; San Bernardino County, by W. B. Tucker and R. J. Sampson, pp. 202-325, 2 maps, 25 illus.; Oil field development operations, by R. D. Bush, pp. 326-329; Progress report, by Olaf P. Jenkins, pp. 330-333, 1 map; Commercial grinding plants in California, by Henry H. Symons, pp. 334-345, 5 illus.

The following is included with report: Map of San Bernardino County showing locations of mines and mineral deposits, scale 1" = 12 mi.

(d) Chapter 4, Mining in California, October 1930, pp. 358-535, i-x, 35 illus. Price 40¢.

Contains: Butte County, by C. A. Logan, pp. 360-412, 10 illus.; Kings County, by Herbert A. Franke, pp. 413-423, 2 illus.; Tulare County, by Herbert A. Franke, pp. 423-471, 19 illus.; Geologic Branch, by Olaf P. Jenkins, pp. 472-474, 1 illus.; Preliminary report on the geology of southwestern Mono County, California, by Evans B. Mayo, pp. 475-482, 3 illus.; Oil field development operations, by R. D. Bush, pp. 483-487; Biennial report of the State Mineralogist, by Walter W. Bradley, pp. 489-494; Our decreasing gold supply, by Alden Anderson, pp. 495-497; Index, pp. 513-535.

*Twenty-seventh Report of the State Mineralogist covering activities of the Division of Mines including the Geologic Branch; Walter W. Bradley, State Mineralogist. 1931. 582 pp., 8 pls., 8 maps, 130 illus.

Issued also in separate chapters, as indicated below.

***(a) Chapter 1, Mining in California, January 1931, pp. 1-127, i-ix, 3 maps, 39 illus.**

Contains: Preliminary report on economic geology of the Shasta quadrangle, by Charles V. Averill, pp. 2-65, 1 map, 31 illus.; Record of progress by Federal departments, by Olaf P. Jenkins, pp. 67-73, 2 maps; Preparation of a new relief map of California, by H. A. Sedelmeyer, pp. 73-77, 2 illus.; Oil field development operations, by R. D. Bush, pp. 78-82; Beryllium and beryl, by Alice V. Petar, pp. 83-97; The new tariff and nonmetallic products, pp. 98-99; Crystalline talc, by Frank R. Wicks, pp. 100-104; Decorative effects in concrete, by Frank R. Wicks, pp. 105-111, 6 illus.

(b) Chapter 2, Mining in California, April 1931, pp. 128-244, i-x, 8 pls., 1 map, 15 illus. Price 40¢.

Contains: The Mountain Copper Company, Ltd., cyanide treatment of gossan, by Charles V. Averill, pp. 129-138, 4 illus.; Publication of papers on the geology of California, by Olaf P. Jenkins, p. 140; Stratigraphic significance of the Kreyenhagen shale of California, by Olaf P. Jenkins,

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pp. 141-186, 11 illus.; Diatoms and silicoflagellates of the Kreyenhagen shale, by G. D. Hanna, pp. 187-201, pls. A-E; Foraminifera of the Kreyenhagen shale, by C. C. Church, pp. 202-213, pls. A-C; Preliminary report of the geology of Santa Cruz Island, Santa Barbara County, California, by William W. Rand, pp. 214-219, 1 map; Oil field development operations, by R. D. Bush, pp. 200-221.

***(c) Chapter 3, Mining in California, July 1931, pp. 245-486, i-xviii, 3 maps, 53 illus.**

Contains: Yuba County, by C. A. Logan, pp. 246-261, 5 illus.; San Bernardino County, by W. B. Tucker and R. J. Sampson, pp. 262-401, 2 maps, 32 illus.; Progress report, by Olaf P. Jenkins, pp. 402-403; Oil field development operations, by R. D. Bush, pp. 404-406; Feldspar, silica, andalusite and cyanite deposits in California, by R. J. Sampson and W. B. Tucker, pp. 407-458, 1 map, 14 illus.; A note on a deposit of andalusite in Mono County, California; its occurrence and technical importance, by J. A. Jeffery and C. D. Woodhouse, pp. 459-464, 2 illus.; Establishment of Trinity and Klamath River fish and game district affects mining, pp. 465-466.

(d) Chapter 4, Mining in California, October 1931, pp. 487-582, 1 map, 23 illus. Price 40¢.

Contains: Alpine County, by C. A. Logan, pp. 488-491; Progress report, by Olaf P. Jenkins, pp. 492-493; Geology of San Jacinto quadrangle south of San Gorgonio Pass, California, by Donald McCoy Fraser, pp. 494-540, 1 map, 23 illus.; Oil field development operations, by R. D. Bush, pp. 541-542; Notes on mining activity in Inyo and Mono Counties in July 1931, by W. B. Tucker, pp. 543-545; Index, pp. 563-582.

*Twenty-eighth Report of the State Mineralogist covering activities of the Division of Mines including the Geologic Branch; Walter W. Bradley, State Mineralogist. 1932. 429 pp., 7 pls., 2 maps, 158 figs.

Issued also in separate chapters, as indicated below.

(a) Chapter 1, Mining in California, January 1932, pp. 1-101, i-xi, pls. 1-3, 45 figs. Price 40¢.

Contains: Economic mineral deposits of the San Jacinto quadrangle, by R. J. Sampson, pp. 3-11, pl. 1, 3 figs.; Contributions to the study of sediments, by Olaf P. Jenkins, pp. 12-13; Geology and physical properties of building stone from Carmel Valley, California, by E. Wayne Galliher, pp. 14-41, pl. 2, 25 figs.; Sediments of Monterey Bay, California, by E. Wayne Galliher, pp. 42-79, pl. 3, 17 figs.; Oil field development operations, by R. D. Bush, pp. 80-81; Sanbornite, a newly described mineral from California, by Walter W. Bradley, pp. 82-83; Sanbornite, a new barium disilicate mineral from Mariposa County, California, by Austin F. Rogers, p. 84; Topographic mapping program for California, by Everett N. Bryan, pp. 85-87; Tariff rate changed on feldspar, p. 87.

*** (b) Chapter 2, Mining in California, April 1932, pp. 102-255, i-xi, 1 map, 71 figs.**

Contains: Progress report, by Olaf P. Jenkins, p. 109; Oil field development operations, by R. D. Bush, pp. 110-111; Elementary placer mining methods and gold-saving devices, by C. McK Laizure, pp. 112-204, 1 map, 65 figs.; The pan, rocker, and sluice box, by Henry H. Symons, pp. 205-213, 5 figs.; Prospecting for vein deposits, by Frank Sanborn, pp. 214-218, 1 fig.; Selected bibliography on placer mining, by Herbert A. Franke, pp. 219-224; Placers of southern California, by R. J. Sampson, pp. 245-255.

***(c) Chapters 3-4, Mining in California, July-October 1932, pp. 256-429, pls. 2-5, 1 map, 42 figs.**

Contains: Ventura County, by W. B. Tucker and R. J. Sampson, pp. 247-277, 6 figs.; Current notes, by Olaf P. Jenkins, p. 278; Report accompanying geologic map of northern Sierra Nevada, by Olaf P. Jenkins, pp. 279-298, 1 map, 8 figs.; Notes on occurrence and age of fossil plants found in the auriferous gravels of Sierra Nevada, by Ralph W. Chaney, pp. 299-302, 2 figs.; Glacial and associated stream deposits of the Sierra Nevada, by Eliot Blackwelder, pp. 303-310, 5 figs., pl. 2; Jurassic and Cretaceous divisions in the Knoxville-Shasta succession of California, by Frank M. Anderson, pp. 311-328, 5 figs., pl. 3; Geology of a part of the Panamint Range, California, by F. M. Murphy, pp. 329-356, 12 figs., pl. 4; Mineral resources of a part of the Panamint Range, by R. J. Sampson, pp. 357-376, 4 figs., pl. 5; Oil field development operations, by R. D. Bush, pp. 377-381; Acquiring mining claims through tax title, pp. 383-384; Biennial Report of the State Mineralogist, by Walter W. Bradley, pp. 385-394, 1 fig.; Index, pp. 411-429.

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* All publications marked with an asterisk (*) are out of print and cannot be obtained from the Division of Mines. Please do not send any money for publications so marked.

The following is included with report: Geologic map of northern Sierra Nevada showing Tertiary river channels and Mother Lode belt, scale ⅛" = 1 mi. (reprinted to accompany Bulletin 135, which see).

*Twenty-ninth Report of the State Mineralogist; Walter W. Bradley, State Mineralogist. 1933. 411 pp., 8 pls., 103 figs.

Issued also in separate chapters, as indicated below.

***(a) Chapters 1-2, California Journal of Mines and Geology, January-April 1933, pp. 1-268, i-xi, pls. 1-5, 78 figs.**

Contains: Gold deposits of the Redding and Weaverville quadrangles, by Charles V. Averill, pp. 2-73, pls. 1-2, 18 figs.; Current notes, by Olaf P. Jenkins, pp. 74-75; Geologic formations of the Redding-Weaverville districts, northern California, by Norman E. A. Hinds, pp. 76-122, pl. 3, 1 fig.; Economic geology of portions of Del Norte and Siskiyou Counties, northwesternmost California, by John H. Maxson, pp. 123-160, pl. 4, 26 figs.; Applications of geology to civil engineering, by Douglas Clark, pp. 161-173; The lakes of California, by William Morris Davis, pp. 175-236, pl. 5, 29 figs.; Oil field development operations, by R. D. Bush, pp. 237-238; Discovery of piedmontite in the Sierra Nevada, by Evans B. Mayo, pp. 239-243, 3 figs.; Suspension of assessment work, p. 243; Tracing buried-river channel deposits by geomagnetic methods, by Elmer W. Ellsworth, pp. 244-250, 2 figs.

The following is included with report or may be purchased separately: Geologic map of the Redding and Weaverville quadrangles and the northwesternmost part of the Red Bluff quadrangle (gold mines located and described by Chas. V. Averill), scale 1" = 4 mi., price 25¢.

(b) Chapters 3-4, California Journal of Mines and Geology, July-October 1933, pp. 268-411, pls. 6-8, 25 figs. Price $1.00.

Contains: Gold resources of Kern County, by W. B. Tucker and R. J. Sampson, pp. 271-339, pls. 6-8, 13 figs.; Oil field development operations, by R. D. Bush, pp. 341-347; Limestone deposits of the San Francisco region, by Edwin C. Eckel, pp. 348-361, 1 map, 7 figs.; Limestone weathering and plant associations of the San Francisco region, by Junea W. Kelly, pp. 362-367, 3 figs.; Booming, by C. McK Laizure, pp. 368-371, 1 fig.; Death Valley National Monument, California, by Herbert Hoover, pp. 371-372, 1 fig.; New state legislation, pp. 373-377; Index, pp. 397-411.

*Thirtieth Report of the State Mineralogist; Walter W. Bradley, State Mineralogist. 1934. 487 pp., 5 pls., 2 maps, 182 illus.

Issued also in separate chapters, as indicated below.

(a) Chapter 1, California Journal of Mines and Geology, January 1934, pp. 1-114, i-xiii, pls. 1-3, 48 illus. Price 60¢.

Contains: Current notes, by Olaf P. Jenkins, pp. 3-4, 1 illus.; Resurrection of early surfaces in the Sierra Nevada, by Olaf P. Jenkins, pp. 5-6; Geology and mineral resources of northeastern Madera County, California,

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by Homer D. Erwin, pp. 7-78, pl. 1, 41 illus.; Geology and mineral deposits of Laurel and Convict basins, southwestern Mono County, California, by Evans B. Mayo, pp. 79-88, pls. 2-3, 4 illus.; Oil field development operations, by R. D. Bush, pp. 89, 90; Notes on sampling as applied to gold quartz deposits, by Homer D. Erwin, pp. 91-99, 2 illus.

*** (b) Chapters 2-3, California Journal of Mines and Geology, April-July 1934, pp. 115-302, i-xiii, 1 map, 97 illus. Price $1.00.**

Contains: Oil field development operations, by R. D. Bush, pp. 118-119; Elementary placer mining in California and notes on the milling of gold ores, by C. McK Laizure with contributions by H. H. Symons, Frank Sanborn, and H. A. Franke, pp. 121-289, 1 map, 97 illus.

*** (c) Chapter 4, California Journal of Mines and Geology, October 1934, pp. 303-487, pls. 4-5, 37 illus.**

Contains: Current mining developments in northern California, by Charles V. Averill, pp. 303-309; Current mining activity in southern California, by W. B. Tucker, pp. 310-327, 6 illus.; Current notes, by Olaf P. Jenkins, pp. 328-329, 1 illus.; Geology and mineral deposits of the Julian district, San Diego County, California, by Maurice Donnelly, pp. 331-370, pl. 4, 13 illus.; Geology and mineral deposits of the Elizabeth Lake quadrangle, California, by Edward C. Simpson, pp. 371-415, pl. 5, 15 illus.; Geologic features of the dry placers of the northern Mojave desert, by Carlton D. Hulin, pp. 416-426, 2 illus.; Oil field development operations, by R. D. Bush, pp. 427-429; Biennial report of the State Mineralogist, by Walter W. Bradley, pp. 431-439; Government cannot challenge right to mining claims for failure to perform annual assessment work within withdrawn areas, pp. 440-443; Death Valley National Monument is now open to mining, pp. 444-445; Index, pp. 474-487.

The following is included with report: Geologic map of Elizabeth Lake quadrangle, scale 1″ = 2 mi.

*Thirty-first Report of the State Mineralogist; Walter W. Bradley, State Mineralogist. 1935. 583 pp., 7 pls., 4 maps, 142 illus.

Issued also in separate chapters, as indicated below.

(a) Chapter 1, California Journal of Mines and Geology, January 1935, pp. 1-110, i-xiv, pl. 1, 1 map, 42 illus. Price 60¢.

Contains: Review of gold mining in east-central California, 1934, by C. A. Logan, pp. 1-23, 9 illus.; Current mining activities in the San Francisco district with special reference to gold, by C. McK Laizure, pp. 24-48, 1 map, 10 illus.; Geological investigation of the clays of Riverside and Orange Counties, southern California, by J. Clark Sutherland, pp. 51-87, pl. 1, 23 illus.; Oil field development operations, by R. D. Bush, pp. 88-93; Information regarding mining loans by the Reconstruction Finance Corporation, pp. 95-99.

The following is included with report, or may be obtained alone: Map of Mariposa County showing principal gold mines, scale 1″ = 3 mi. Price 25¢.

(b) Chapter 2, California Journal of Mines and Geology, April 1935, pp. 111-254, i-xiv, pls. 2-3, 43 illus. Price 60¢.

Contains: Current notes [Preliminary legend of rock formation units used on the new geologic map of California], by Olaf P. Jenkins, pp. 112-114; A geologic section across the southern Peninsular Range of California, by William J. Miller, pp. 115-142, pl. 2, 8 illus.; New technique applicable to the study of placers, by Olaf P. Jenkins, pp. 143-210, pl. 3, 35 illus.; Oil field development operations, by R. D. Bush, pp. 211-214; Grubstake permits, by Charles F. Johnson, pp. 215-219.

*** (c) Chapter 3, California Journal of Mines and Geology, July 1935, pp. 255-400, i-xiv, pls. 4-5, 1 map, 15 illus.**

Contains: Mines and mineral resources of Siskiyou County, by Charles V. Averill, pp. 255-338, pl. 4, 13 illus.; Oil field development operations, by R. D. Bush, pp. 340-344; Dams for hydraulic mining debris, by Walter W. Bradley, pp. 345-367, pl. 5, 2 illus.; Leasing system as applied to metal mining, by W. O. Vanderburg, pp. 368-375; Mine financing in California, by Philip S. Matthews, pp. 376-381; New laws make radical change in mining rights, pp. 382-384.

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* All publications marked with an asterisk (*) are out of print and cannot be obtained from the Division of Mines. Please do not send any money for publications so marked.

The following is included with report: Map of western portion of Siskiyou County showing locations of principal gold mines, scale 1½" = 5 mi.

(d) Chapter 4, California Journal of Mines and Geology, October 1935, pp. 401-583, pls. 6-7, 2 maps, 42 illus. Price 60¢.

Contains: Mines and mineral resources of San Luis Obispo County, by Herbert A. Franke, pp. 402-461, 1 map, 16 illus.; Mineral resources of portions of Monterey and Kings County, by Herbert A. Franke, pp. 462-464; Mining activity at Soledad Mountain and Middle Buttes, Mojave mining district, Kern County, by W. B. Tucker, pp. 465-485, pls. 6-7, 11 illus.; Current notes, by Olaf P. Jenkins, p. 486; Geology of a portion of the Perris block, southern California, by Paul H. Dudley, pp. 487-506, 1 map, 10 illus.; Mineral resources of a portion of the Perris block, Riverside County, California, by R. J. Sampson, pp. 507-521, 5 illus.; Oil field development operation, by R. D. Bush, pp. 522-525; Index, pp. 556-583.

The following is included with report, or may be obtained alone: Geologic map, portion of Perris block, southern California, scale 1" = 2½ mi., price 25¢.

*Thirty-second Report of the State Mineralogist; Walter W. Bradley, State Mineralogist. 1936. 563 pp., 10 pls., 2 maps, 96 illus.

Issued also in separate chapters, as indicated below.

(a) Chapter 1, California Journal of Mines and Geology, January 1936, pp. 1-124, i-xiv, 10 illus. Price 60¢.

Contains: Gold mines of Placer County, by C. A. Logan, pp. 7-96, 5 illus.; Borax Lake, California, by M. Vonsen and G. D. Hanna, pp. 99-108, 5 illus.; Oil field development operations, by R. D. Bush, pp. 109-112.

(b) Chapter 2, California Journal of Mines and Geology, April 1936, pp. 125-224, i-xiii, 1 map, 25 illus. Price 60¢.

Contains: Oil field development operations, by R. D. Bush, pp. 128-131; Geology, mining, and processing of diatomite at Lompoc, Santa Barbara County, California, by Henry Mulryan, pp. 133-166, 1 map, 23 illus.; Essentials in developing and financing a prospect into a mine, by Charles Will Wright, pp. 167-188; The gold-bearing veins of Meadow Lake district, Nevada County, by A. L. Wisker, pp. 189-204, 2 illus.

(c) Chapter 3, California Journal of Mines and Geology, July 1936, pp. 225-404, i-xiv, pls. 1-8, 1 map, 28 illus. Price 60¢.

Contains: Mines and mineral resources of Calaveras County, by C. A. Logan and Herbert A. Franke, pp. 226-364, pls. 1-8, 28 illus.; Current notes, by Olaf P. Jenkins, p. 366; Oil field development operations, by R. D. Bush, pp. 367-371; Placer mining in California with power shovels, by C. A. Logan, pp. 373-377; Assessment work on mining claims within withdrawn areas, pp. 378-381; Joshua Tree National Monument, pp. 382-383, 1 map; Cost of producing quicksilver at a California mine in 1931-1932, pp. 384-385; The age of mineral utilization, by John Wellington Finch, pp. 386-390.

(d) Chapter 4, California Journal of Mines and Geology, October 1936, pp. 405-563, pls. 1-2, 33 illus. Price 60¢.

Contains: Mineral resources of Lassen County, by Charles V. Averill and Homer D. Erwin, pp. 405-444, pls. 1-2, 14 illus.; Mineral resources of Modoc County, by Charles V. Averill, pp. 445-457, 5 illus.; Current notes, by Olaf P. Jenkins, p. 458; Mechanics of the Lone Mountain landslides, San Francisco, California, by William M. Cogan, pp. 459-474, 14 illus.; Oil field development operations, by R. D. Bush, pp. 475-479; Biennial report of the State Mineralogist, by Walter W. Bradley, pp.

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481-489; Properties and industrial applications of opaline silica, by John T. Thorndyke, pp. 490-494; Index, pp. 525-563.

*Thirty-third Report of the State Mineralogist; Walter W. Bradley. State Mineralogist. 1937. 385 pp., 4 pls., 1 map, 62 illus.

Issued also in separate chapters, as indicated below.

(a) Chapter 1, California Journal of Mines and Geology, January 1937, pp. 1-78, i-xiii, pl. 1, 12 illus. Price 60¢.

Contains: Source data of the geologic map of California, January 1937, by Olaf P. Jenkins, pp. 9-37, pl. 1; The geology of quicksilver ore deposits, by C. N. Schuette, pp. 38-50, 11 illus.; Oil field development operations, by R. D. Bush, pp. 51-54; Prospecting for lode gold, by E. D. Gardner, pp. 57-66.

(b) Chapter 2, California Journal of Mines and Geology, April 1937, pp. 79-172, i-xiii, pl. 2, 23 illus. Price 60¢.

Contains: Mineral resources of Plumas County, by Charles V. Averill, pp. 79-143, pl. 2, 13 illus.; Current notes, by Olaf P. Jenkins, pp. 145-146; Oil field development operations, by R. D. Bush, pp. 147-152; New placer mining debris law, pp. 154-155.

The following is included with report, or may be obtained alone: Map of Plumas County, showing areal geology and locations of principal mines, scale 1″ = 3½ mi., price 25¢.

*** (c) Chapter 3, California Journal of Mines and Geology, July 1937, pp. 173-261, i-xiii, pl. 3, 1 map, 16 illus.**

Contains: Mineral resources of Los Angeles County, by R. J. Sampson, pp. 173-213, 1 map, 8 illus.; Current notes, by Olaf P. Jenkins, p. 214, 1 illus.; Geology and mineral deposits of the western San Gabriel Mountains, Los Angeles County, by Gordon B. Oakeshott, pp. 215-249, pl. 3, 7 illus.

The following is included with report: Map of Los Angeles County, California, showing the principal mines and oil fields, scale 1″ = 4 mi.

(d) Chapter 4, California Journal of Mines and Geology, October 1937, pp. 262-385, pl. 5, 21 illus. Price 60¢.

Contains: Mineral resources of the Resting Springs region, Inyo County, by R. J. Sampson, pp. 264-270, pl. 5, 2 illus.; Current notes, by Olaf P. Jenkins, pp. 270-272; Paleozoic section in the Nopah and Resting Springs Mountains, Inyo County, California, by John C. Hazzard, pp. 273-339, 19 illus.; Native arsenic from Grass Valley, California, by W. D. Johnston, Jr., p. 340; Index, pp. 369-385.

*Thirty-fourth Report of the State Mineralogist; Walter W. Bradley, State Mineralogist. 1938. 669 pp., 7 pls., 115 illus.

Issued also in separate chapters, as indicated below.

*** (a) Chapter 1, California Journal of Mines and Geology, January 1938, pp. 1-94, i-xiv, 13 illus.**

Contains: Mineral development and mining activity in southern California during the year 1937, by W. B. Tucker, pp. 8-19; Doing something about earthquakes, by R. R. Lukens, pp. 21-26, 6 illus.; Gold and petroleum in California, by Waldemar Lindgren, pp. 27-32; Gem minerals of California, by Francis J. Sperisen, pp. 34-78, 7 illus.

(b) Chapter 2, California Journal of Mines and Geology, April 1938, pp. 95-204, i-xv, pl. 1, 32 illus. Price 60¢.

Contains: Gold dredging in Shasta, Siskiyou and Trinity Counties, by Charles V. Averill, pp. 96-126, 16 illus.; Current notes, by Olaf P. Jenkins, pp. 127-129, 1 illus.; Geology of the central Santa Monica mountains, Los Angeles County, by E. K. Soper, pp. 131-180, pl. 1, 15 illus.; Marketing mica, by Paul M. Tyler, pp. 182-187.

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* All publications marked with an asterisk (*) are out of print and cannot be obtained from the Division of Mines. Please do not send any money for publications so marked.

The following is included with report: Geologic map of Los Flores and Dry Canyon quadrangles and western part of Topanga Canyon quadrangle, Santa Monica Mountains, California, scale 2″ = 1¾ mi.

(c) Chapter 3, California Journal of Mines and Geology, July 1938, pp. 205-366, i-xiv, pl. 2, 36 illus. Price 60¢.

Contains: Mineral resources of El Dorado County, by C. A. Logan, pp. 206-280, pl. 2, 18 illus.; Current notes, by Olaf P. Jenkins, pp. 281-282; Strategic minerals in California, by Charles White Merrill, pp. 283-291; Mineral highlights of California, by Walter W. Bradley, pp. 292-297; Submarine canyons off the California coast, by Francis P. Shepard, pp. 298-310, 9 illus.; The Mountain Copper Company, Ltd., cyanide treatment of gossan, by Charles V. Averill, pp. 312-330, 9 illus.; Use of ultra-violet light in prospecting for scheelite, by Ott F. Heizer, pp. 331-333; New State Lands Act of 1938, pp. 334-347; New amendment to the "Caminetti Act," 1938, p. 348.

The following is included with report: Map of western portion of El Dorado County showing mining claims, scale 1″ = 2 mi.

*** (d) Chapter 4, California Journal of Mines and Geology, October 1938, pp. 367-669, pls. 3-7, 34 illus.**

Contains: Mineral resources of Inyo County, by W. B. Tucker and R. J. Sampson, pp. 368-500, pls. 3-4, 33 illus.; Geology and ore deposits of the Darwin silver-lead mining district, Inyo County, California, by Vincent C. Kelley, pp. 503-562, pls. 5-7, 31 illus.; Sulphur deposits of Inyo County, California, by Edward D. Lynton, pp. 563-590, 14 illus.; Biennial report of the State Mineralogist, by Walter W. Bradley, pp. 592-597, 1 illus.; Index, pp. 633-669.

The following is included with report: Map of Inyo County, California, showing location of principal mines, scale 2½″ = 15 mi.

*Thirty-fifth Report of the State Mineralogist; Walter W. Bradley, State Mineralogist. 1939. 552 pp., 4 pls., 86 illus.

Issued also in separate chapters, as indicated below.

*** (a) Chapter 1, California Journal of Mines and Geology, January 1939, pp. 1-106, i-xv, pl. 1, 15 illus. Price 60¢.**

Contains: Mineral resources of San Diego County, by W. B. Tucker and Charles H. Reed, pp. 8-55, pl. 1, 7 illus.; Geology and oil possibilities of southwestern San Diego County, by Leo George Hertlein and U. S. Grant IV, pp. 57-78, 8 illus.; The prospect for "minor metals" and nonmetallic minerals, by John Wellington Finch, pp. 80-88; The right to mine, by Robert M. Searls, pp. 89-95.

The following is included with report: Map of San Diego County showing location of principal mineral deposits, scale 1″ = 3 mi.

(b) Chapter 2, California Journal of Mines and Geology, April 1939, pp. 107-214, i-xiv, pl. 2, 19 illus. Price 60¢.

Contains: Mineral resources of Shasta County, by Charles V. Averill, pp. 108-191, pl. 2, 19 illus.; The public's interest in mine taxation, by A. G. Mackenzie, pp. 194-198.

The following is included with report, or may be obtained alone: Map of Shasta County showing locations of principal mineral deposits, scale 1″ = 3 mi., price 25¢.

(c) Chapter 3, California Journal of Mines and Geology, July 1939, pp. 215-348, i-xvi, pls. 3-4, 26 illus. Price 60¢.

Contains: Tertiary formations of northern Sacramento Valley, California, by Charles A. Anderson and R. Dana Russell, pp. 219-253, pl. 3, 14 illus.; Geology and oil possibilities of Caliente Range, Cuyama Valley, and Carrizo Plain, California, by J. E. Eaton, pp. 255-274, pl. 4, 5 illus.; Bibliography of the geology and mineral resources of California for the year 1937, prepared under the direction of Solon Shedd, with introduction by Olaf P. Jenkins, pp. 275-307; The Giant Goose Lake meteorite from

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*** All publications marked with an asterisk (*) are out of print and cannot be obtained from the Division of Mines. Please do not send any money for publications so marked.**

Modoc County, California, by Earle G. Linsley, pp. 308-312, 3 illus.; Costs of trucking and packing ore in western gold-mining districts, by E. D. Gardner, pp. 314-330, 4 illus.; Strategic Minerals Act, pp. 331-333; Assessment work on mining claims for 1938-1939, p. 334; New mining legislation, 1939, pp. 335-337.

*** (d) Chapter 4, California Journal of Mines and Geology, October 1939, pp. 349-552, 26 illus.**

Contains: Current notes, by Olaf P. Jenkins, pp. 350-351; Quicksilver resources of California, by Alfred L. Ransome and John L. Kellogg, pp. 353-486, 26 illus.; Sulphate minerals at the Leviathan sulphur mine, Alpine County, California, by George L. Gary, pp. 488-489; Index, pp. 523-552.

The following reprint may be obtained alone: Quicksilver resources of California, by Alfred L. Ransome and John L. Kellogg, pp. 353-486, 26 illus. Price 50¢.

Thirty-sixth Report of the State Mineralogist; Walter W. Bradley, State Mineralogist. 1940. 494 pp., 5 pls., 127 illus. Price, cloth-bound volume, $3.00.

Issued also in separate chapters, as indicated below.

(a) Chapter 1, California Journal of Mines and Geology, January 1940, pp. 1-114, i-xvi, 20 illus. Price 60¢.

Contains: Current mining activity in southern California, by W. B. Tucker and R. J. Sampson, pp. 9-82, 20 illus.; Notes on beryl with a qualitative analysis for beryllium, by George L. Gary, pp. 86-95; Strategic minerals investigation procedure followed by the U. S. Bureau of Mines, by John W. Finch, pp. 96-100.

(b) Chapter 2, California Journal of Mines and Geology, April 1940, pp. 115-230, i-xvi, pl. 1, 43 illus. Price 60¢.

Contains: Mineral resources of Mono County, by R. J. Sampson and W. B. Tucker, pp. 117-156, pl. 1, 11 illus.; General geology and ores of the Blind Spring Hill mining district, Mono County, California, by Alfred L. Ransome, pp. 159-197, 28 illus.; Short report on the geological formations encountered in driving the Mono Craters tunnel, compiled by W. K. Gresswell, pp. 199-204, 3 illus.; Methods and costs of mining and concentrating chromite, by Alfred Burch and Samuel H. Dolbear, pp. 205-210, 1 illus.

The following is included with the report or may be obtained separately: Map of Mono County showing location of principal mining properties, scale 1″ = 6 mi., price 25¢.

(c) Chapter 3, California Journal of Mines and Geology, July 1940, pp. 231-320, i-xvi, pls. 2-3, 10 illus. Price 60¢.

Contains: Economic mineral deposits of the Newberry and Ord Mountains, San Bernardino County, by W. B. Tucker and R. J. Sampson, pp. 232-254, 1 illus.; Current notes, by Olaf P. Jenkins, pp. 255-256; Geology of the Newberry and Ord Mountains, San Bernardino County, California, by Dion L. Gardner, pp. 257-292, pl. 2, 9 illus.; Notes on the geology of a portion of the Calico Mountains, San Bernardino County, California, by Homer D. Erwin and Dion L. Gardner, pp. 293-304, pl. 3; Study of chrome process aided by Martin Dennis Company, p. 305.

(d) Chapter 4, California Journal of Mines and Geology, October 1940, pp. 321-494, pls. 2-3, 54 illus. Price 60¢.

Contains: Mineral resources of the Kernville quadrangle, by W. B. Tucker and R. J. Sampson, pp. 322-333, 1 illus.; Strategic problems of the mineral industry in California, by Olaf P. Jenkins, pp. 335-341; Descriptive geology of the Kernville quadrangle, California, by William J. Miller and Robert W. Webb, pp. 343-378, pl. 2, 31 illus.; Geology of the Big Blue group of mines, Kernville, California, by John W. Prout Jr., pp. 379-421, pl. 3, 22 illus.; Biennial report of the State Mineralogist, by Walter W. Bradley, pp. 423-431; Strategic tax exemption, p. 432; Federal loans for strategic minerals, an Act, pp. 432-433; Index, pp. 481-494.

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The following is included with report, or may be obtained separately: Geologic map of Kernville quadrangle, California, scale 1″ = 2 mi., price 25¢.

Thirty-seventh Report of the State Mineralogist; Walter W. Bradley, State Mineralogist. 1941. 656 pp., 3 pls., 1 map, 99 illus. Price, cloth-bound volume, $3.00.

Issued also in separate chapters, as indicated below.

(a) Chapter 1, California Journal of Mines and Geology, January 1941, pp. 1-200, i-xvi, pl. 1, 50 illus. Price 60¢.

Contains: Mineral resources of Trinity County, by Charles V. Averill, pp. 8-89, pl. 1, 19 illus.; Current notes, by Olaf P. Jenkins, p. 90; Strategic minerals procurement, by Charles W. Merrill, pp. 91-100; Geological investigation of the chromite deposits of California, by John Eliot Allen, pp. 101-167, 31 illus.; United States Supreme Court renders far-reaching decision on power permits on "navigable" streams, pp. 169-183; Securities and Exchange Commission, Securities Act of 1933, pp. 184-189.

The following is included with report, or may be obtained alone: Map of Trinity County showing locations of principal mineral deposits, scale 1″ = 4 mi., price 25¢.

(b) Chapter 2, California Journal of Mines and Geology, April 1941, pp. 201-372, i-xvii, 24 illus. Price 60¢.

Contains: Current notes, by Olaf P. Jenkins, pp. 202-203; Geological progress of the California State Division of Mines, 1930 to 1940, by Olaf P. Jenkins, pp. 205-217; California earthquakes of the Mission period, 1769-1838, by Robert F. Heizer, pp. 219-223; Occurrence of scheelite in Idaho-Maryland mines at Grass Valley, California, by Rollin Farmin, p. 224; Tungsten resources of California, by John F. Partridge Jr., pp. 225-326, 22 illus.; Dragline dredging in Siskiyou County, by Charles V. Averill, pp. 328-331, 2 illus.; Marketing talc, pyrophyllite, and ground soapstone, by Bertrand L. Johnson, pp. 332-341; Manganese, by George L. Gary, pp. 342-344; Magnesite, by George L. Gary, pp. 345-347.

(c) Chapter 3, California Journal of Mines and Geology, July 1941, pp. 373-496, i-xvii, pls. 2-3, 1 map, 11 illus. Price 60¢.

Contains: Mineral resources of Nevada County, by C. A. Logan, pp. 374-408, pls. 2-3, 1 map, 6 illus.; Mining methods and costs of the Lava Cap Gold Mining Corporation, Nevada City, California, by John W. Chandler, pp. 409-436, 4 illus.; The price of gold, by Arthur B. Foote, pp. 437-468, 1 illus.; Current notes, by Olaf P. Jenkins, pp. 469-470; History of the names cobalt and nickel, by W. B. Winston, pp. 472-474; Aluminum, by George L. Gary, pp. 475-477; Quartz, by George L. Gary, pp. 478-482; New mining laws, an Act to amend Sec. 2313 of the Public Resources Code, pp. 483-485.

The following are included with report, or may be obtained alone: Large-scale map, Grass Valley and Nevada City district, showing mining claims, scale 1⅝″ = 1 mi., price 25¢; Map of western portion Nevada County, California, showing mining claims, scale 2″ = 3 mi., price 25¢.

(d) Chapter 4, California Journal of Mines and Geology, October 1941, pp. 497-656, 14 illus. Price 60¢.

Contains: Mineral resources of Humboldt County, by Charles V. Averill, pp. 499-528, 7 illus.; Tin in California, by Richard J. Segerstrom, pp. 531-557, 4 illus.; California quicksilver program of the Federal Geological Survey, by Edwin B. Eckel, pp. 558-563; Recent developments in the tungsten resources of California, by W. B. Tucker and R. J. Sampson, pp. 565-588, 3 illus.; New manganese and chrome ore specifications and prices, pp. 589-592; Does scheelite always fluoresce?, by George L. Gary, p. 593; Bentonite, by George L. Gary, pp. 594-596; Index, pp. 627-656.

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*Thirty-eighth Report of the State Mineralogist; Walter W. Bradley, State Mineralogist. 1942. 414 pp., 9 pls., 1 map, 100 figs.

Issued also in separate chapters, as indicated below.

(a) Chapter 1, California Journal of Mines and Geology, January 1942, pp. 1-104, i-xvii, 19 figs. Price 60¢.

Contains: Mines and mineral resources of Sierra County, by Charles V. Averill, pp. 7-67, 17 figs.; Chromium, by Charles V. Averill, pp. 70-93, 2 figs.

(b) Chapter 2, California Journal of Mines and Geology, April 1942, pp. 105-220, i-xvii, pls. 1-3, 30 figs. Price 60¢.

Contains: Mineral resources of Imperial County, by R. J. Sampson and W. B. Tucker, pp. 105-145, pl. 1, 11 figs.; Geology and mineral deposits of the Cargo Muchacho Mountains, Imperial County, California, by Paul C. Henshaw, pp. 147-196, pls. 2-3, 15 figs.; Imperial carbon-dioxide gas field, by James C. Bransford, pp. 198-201, 4 figs.; The legendary "white metal" and its "ore", by C. W. Davis, pp. 202-205; Mine assessment work suspended on claims within withdrawn areas, an Act of Congress, p. 206.

The following is included with report: Map of Imperial County showing locations of principal mineral deposits, scale 2″ = 15 mi.

(c) Chapter 3-4, California Journal of Mines and Geology, July-October 1942, pp. 221-414, pls. 4-9, 1 map, 51 figs. Price $1.20.

Contains: Hot springs deposits of the Coso Mountains, by H. J. Fraser, H. D. B. Wilson, and N. W. Hendry, pp. 223-242, pls. 4-6, 1 map, 16 figs.; Contact-metamorphic rocks of the Twin Lakes region, Fresno County, California, by Charles W. Chesterman, pp. 243-282, pl. 7, 32 figs.; Tungsten deposits of the Confidence mining district, Tuolumne County, California, by James M. Little, pp. 283-290, pl. 8; Geology of the Welsh tungsten deposits, Madera County, California, by James M. Little, pp. 291-294, pl. 9; Ghost Canyon tungsten claims, Madera County, California, by James M. Little, pp. 295-302, 3 figs.; Tabulation of tungsten deposits of California to accompany economic mineral map No. 4, prepared under the direction of Olaf P. Jenkins, pp. 303-364; Biennial report of the State Mineralogist, by Walter W. Bradley, pp. 367-378; Index, pp. 399-414.

The following is included with report, or may be purchased alone: Outline geologic map of California showing locations of tungsten properties (Economic mineral map of California No. 4—Tungsten), scale 1:1,000,000, price 60¢.

*Thirty-ninth Report of the State Mineralogist; Walter W. Bradley, State Mineralogist. 1943. 609 pp., 8 pls., 123 figs.

Issued also in separate chapters, as indicated below.

(a) Chapter 1, California Journal of Mines and Geology, January 1943, pp. 1-110, i-xvi, pls. 1-2, 23 figs. Price 60¢.

Contains: Mines and mineral resources of Santa Cruz County, by Henry G. Hubbard, pp. 11-52, pls. 1-2, 21 figs.; Discoveries in the strategic minerals, San Francisco field district, by C. McK Laizure, pp. 53-57; Current notes on activity in the strategic minerals, Los Angeles field district, by W. B. Tucker and R. J. Sampson, pp. 58-70; Current notes on activity in the strategic minerals, Sacramento field district, by Charles V. Averill, pp. 71-76, 2 figs.; Current notes on activity in the strategic minerals, Redding field district, by J. C. O'Brien, pp. 77-84; Current mining activity in Plumas County, by C. A. Logan, pp. 85-87; Current notes [Recent publications on strategic minerals by the U. S. Geological Survey], by Olaf P. Jenkins, pp. 88-89; Department of the Interior information service [Chromite deposits on North Elder Creek, Tehama County; Chromite deposits of McGuffy Creek area, Siskiyou County; Fairview and Ladd chromite deposits, Siskiyou County; Chromite deposits near San Luis Obispo; Manganese deposits of the Ladd-Buckeye area near Tracy; Quicksilver deposits of the New Idria district; New methods for determination of molybdenum in scheelite], by United States Geological Survey, pp. 90-102.

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* All publications marked with an asterisk (*) are out of print and cannot be obtained from the Division of Mines. Please do not send any money for publications so marked.

The following is included with report, or may be obtained alone: Map of Santa Cruz County (showing location of principal mineral properties), scale 1″ = 3 mi., price 25¢.

(b) Chapter 2, California Journal of Mines and Geology, April 1943, pp. 111-292, i-xvi, pls. 3-4, 44 figs. Price 60¢.

Contains: Manganese discovery in San Mateo County, by Henry G. Hubbard, p. 117, 1 fig.; Current mining activity in southern California, by W. B. Tucker and R. J. Sampson, pp. 118-138, 2 figs.; Current notes on activity in the strategic minerals, Sacramento field district, by Charles V. Averill, pp. 139-141, 1 fig.; Clerbus-Mae tungsten prospect, Trinity County, by J. C. O'Brien, p. 142; Current notes, by Olaf P. Jenkins, pp. 143-144, 1 fig.; Mylonites in the eastern San Gabriel Mountains, by Raymond M. Alf, pp. 145-151, 6 figs.; Geology of the Sierra Nevada northeast of Visalia, Tulare County, California, by Cordell Durrell, pp. 153-168, pls. 3-3A; Tungsten deposits northeast of Visalia, by William O. Jenkins, pp. 169-182, 3 figs.; Geology of the San Benito quadrangle, California, by Ivan F. Wilson, pp. 183-270, pl. 3, 30 figs.; Lithium, by George L. Gary, pp. 276-278; Quartz, by W. B. Winston, pp. 278-284.

The following is included with report, or may be purchased alone: Geologic map of the San Benito quadrangle, California, scale 1:62,500, pl. 3. Price 40¢.

(c) Chapter 3, California Journal of Mines and Geology, July 1943, pp. 293-420, i-xvii, 25 figs. Price 60¢.

Contains: Carbon dioxide gas occurrences in Mendocino and northern Sonoma Counties, by Henry G. Hubbard, pp. 301-309, 8 figs.; Current notes on activity in the strategic minerals, Sacramento field district, by Charles V. Averill, pp. 311-322, 4 figs.; Current notes on the activity in the strategic minerals, Redding field district, by J. C. O'Brien, pp. 323-330; Crestmore minerals, by A. O. Woodford, pp. 333-365, 7 figs., The isometrograph as developed and used at the New Idria quicksilver mine, by J. McLaren Forbes, pp. 367-376, 6 figs.; Discussion of Bulletin 118—notes relating to Sutter (Marysville) Buttes gas field, by Walter Stalder, pp. 377-381; The sillimanite group of minerals, by Joseph A. Jeffery, pp. 383-390; New federal and state legislation affecting mining, pp. 391-409.

***(d) Chapter 4, California Journal of Mines and Geology, October 1943, pp. 421-609, pls. 5-8, 31 figs.**

Contains: Mineral resources of San Bernardino County, by W. B. Tucker and R. J. Sampson, pp. 427-549, pls. 5-7, 27 figs.; Current notes on activity in the strategic minerals, Sacramento field district, by Charles V. Averill, pp. 551-559, 4 figs.; Current notes, by Olaf P. Jenkins, pp. 560-561, pl. 8; Geologic map of a portion of the Foothill copper belt, Calaveras County, California, by Stanford Geological Survey, pl. 8; Index, pp. 593-609.

The following is included with report: Map of San Bernardino County, California, showing locations of mines and mineral deposits, scale 1″ = 8 mi.

Fortieth Report of the State Mineralogist; Walter W. Bradley, State Mineralogist. 1944. 509 pp., 12 pls., 8 maps, 97 figs. Price, cloth-bound volume, $3.00.

Issued also in separate chapters, as indicated below.

***(a) Chapter 1, California Journal of Mines and Geology, January 1944, pp. 1-162, pls. 1-7, 43 figs.**

Contains: Geology of Palm Springs-Blythe strip, Riverside County, California, by William J. Miller, pp. 11-72, pls. 1-4, 23 figs.; Geology of parts of the Barstow quadrangle, San Bernardino County, California, by

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William J. Miller, pp. 73-112, pls. 5-6, 18 figs.; Geology of the Needles-Goffs region, San Bernardino County, California, by William J. Miller, pp. 113-129, pl. 7, 1 fig.; Airox concrete aggregate, by S. G. Dolman, pp. 131-133, 1 fig.; Marketing magnesite and allied products, by Charles L. Harness and Nan C. Jensen, pp. 134-149.

(b) Chapter 2, California Journal of Mines and Geology, April 1944, pp. 163-282, i-xvii, pls. 8-10, 32 figs. Price 60¢.

Contains: Status of topographic and geologic mapping in California, by Olaf P. Jenkins, pp. 171-176, pl. 8; Geology of the Jamesburg quadrangle, Monterey County, California, by William Morris Fiedler, pp. 177-250, pls. 9-10, 32 figs.

The following are included with report: Map of California showing progress in topographic quadrangles and geologic maps, scale 1" = 40 mi. (approx.); and Map of California showing distribution of mineral deposits, scale 1" = 40 mi. (approx.). Geologic map of the Jamesburg quadrangle, Monterey County, California, scale 1:62,500; and Structure sections across Jamesburg quadrangle, Monterey County, California, price 40¢.

(c) Chapter 3, California Journal of Mines and Geology, July 1944, pp. 283-392, i-xvii, 8 maps, 12 figs. Price 60¢.

Contains: Progress on revision of Bulletin 113, Minerals of California, by Joseph Murdoch and Robert W. Webb, p. 290; Mines and quarries of the Indians of California, by Robert F. Heizer and Adan E. Treganza, pp. 291-359, 8 maps, 11 figs.; Fluorescent minerals in the exhibit of the State Division of Mines, by Henry H. Symons, pp. 361-368, 1 fig.; Fluorescent minerals used in lighting and elsewhere, by Oliver C. Ralston and A. George Stern, pp. 369-380.

(d) Chapter 4, California Journal of Mines and Geology, October 1944, pp. 393-500, pls. 11-12, 9 figs. Price 60¢.

Contains: Biennial report of the State Mineralogist, by Walter W. Bradley, pp. 401-408; Pellet phosphorite from Carmel Valley, Monterey County, California, by Austin F. Rogers, pp. 411-421, 6 figs.; Geology of the quartz-crystal mines near Mokelumne Hill, Calaveras County, California, by Cordell Durrell, pp. 423-433, pls. 11-12, 3 figs.; Strategic mica, by G. Richards Gwinn, pp. 435-447; Additional note on strategic mica, by Charles V. Averill, pp. 448-449; Marketing vermiculite, by G. Richards Gwinn, pp. 450-459; An Act providing for the suspension of certain requirements relating to work on tunnel sites, p. 460; An Act regulating mineral, oil, and gas brokers and salesmen, pp. 461-470; Index, pp. 501-509.

Forty-first Report of the State Mineralogist; Walter W. Bradley, State Mineralogist. 1945. 401 pp., 50 pls., 12 figs. Price, cloth-bound volume, $3.00.

Issued also in separate chapters, as indicated below.

(a) Chapter 1, California Journal of Mines and Geology, January 1945, pp. 1-54, i-xviii, pls. 1-5, 3 figs. Price 60¢.

Contains: Quicksilver deposits of central San Benito and northwestern Fresno Counties, California, by Robert G. Yates and Lowell S. Hilpert, pp. 11-35, pls. 1-5, 3 figs.; War-time mineral industry of California, by Spangler Ricker, pp. 37-44.

(b) Chapter 2, California Journal of Mines and Geology, April 1945, pp. 55-110, i-xviii, pls. 6-22, 2 figs. Price 60¢.

Contains: Quicksilver deposits of the Knoxville district, Napa, Yolo, and Lake Counties, California, by Paul Averitt, pp. 65-89, pls. 6-14, 2 figs.; Unexpected use transforms outlook for quicksilver, by H. H. Wanders, pp. 91-92; Steel, by William H. Popert, pp. 93-96, pls. 15-22.

(c) Chapter 3, California Journal of Mines and Geology, July 1945, pp. 111-220, i-xviii, pls. 23-35. Price 60¢.

Contains: Mineral resources of Riverside County, by W. B. Tucker and R. J. Sampson, pp. 121-182, pls. 23-35; Recent legislation affecting mining, pp. 183-191; Carbon, by W. B. Winston, pp. 196-208; Fluorspar, by W. B. Winston, pp. 209-212.

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The following is included with report: Map of Riverside County, California, showing locations of mines and mineral deposits, scale 1″ = 6 mi., price 25¢.

(d) Chapter 4, California Journal of Mines and Geology, October 1945, pp. 221-401, pls. 36-50, 7 figs. Price 60¢.

Contains: Pine Creek and Adamson tungsten mines, Inyo County, California, by Paul C. Bateman, pp. 231-249, pls. 36-47, 1 fig.; Index to topographic quadrangles of California, by Mary H. Helm with Introduction by Olaf P. Jenkins, pp. 251-360, 6 figs.; Flow-sheet of American Potash and Chemical Corporation at Searles Lake, California, by Walter W. Bradley, pp. 361-363, pls. 48-50; Index, pp. 393-401.

Forty-second Report of the State Mineralogist; Walter W. Bradley, W. B. Tucker, State Mineralogists. 1946. 430 pp., 55 pls., 40 figs. Price, cloth-bound volume, $3.00.

Issued also in separate chapters, as indicated below.

(a) Chapter 1, California Journal of Mines and Geology, January 1946, pp. 1-73, i-xviii, pls. 1-7, 8 figs. Price 60¢.

Contains: Geology of Santa Rosa Mountain area, Riverside County, California, by Lawrence B. Wright, pp. 9-13, pl. 1, 2 figs.; Geology and nickel mineralization of the Julian-Cuyamaca area, San Diego County, California, by S. C. Creasey, pp. 15-29, pls. 2-4, 2 figs.; Tin deposits of the Gorman district, Kern County, California, by John H. Wiese and Lincoln R. Page, pp. 31-52, pls. 5-7, 4 figs.; California minerals for tomorrow, by Walter W. Bradley, pp. 53-56; Relocation of claim by original locator, State of California District Court appeal, pp. 57-60.

(b) Chapter 2, California Journal of Mines and Geology, April 1946, pp. 74-164, i-xviii, pls. 8-22, 17 figs. Price 60¢.

Contains: Quicksilver deposits of the New Idria district, San Benito and Fresno Counties, California, by Edwin B. Eckel and W. B. Myers, pp. 81-124, pls. 8-20, 9 figs.; Quicksilver deposits at the Sulphur Bank mine, Lake County, California, by Donald L. Everhart, pp. 125-153, pls. 21-22, 8 figs.

(c) Chapter 3, California Journal of Mines and Geology, July 1946, pp. 165-310, pls. 23-50, 11 figs. Price 60¢.

Contains: Biennial report of the State Mineralogist, by Walter W. Bradley, pp. 173-182; Mines and mining in Tehama County, California, by J. C. O'Brien, pp. 183-195, pls. 23-38; Progress on revision of Bulletin 113, "Minerals of California," with notes on some new occurrences, by Joseph Murdoch, pp. 197-198; Quicksilver deposits of the western Mayacmas district, Sonoma County, California, by Edgar H. Bailey, pp. 199-230, frontispiece, pls. 30-33, 3 figs.; Quicksilver deposits of eastern Mayacmas district, Lake and Napa Counties, California, by Robert G. Yates and Lowell S. Hilpert, pp. 231-286, pls. 29, 34-47, 8 figs.; Minerals at "The Geysers," Sonoma County, California, by M. Vonsen, pp. 287-293, pl. 48; Observations at "The Geysers," Sonoma County, California, by Walter W. Bradley, pp. 295-298, pls. 49-50.

The following are included with report or may be purchased separately: * Map of Tehama County, California, showing locations of principal mineral deposits, scale 1″ = 6 mi., approx.; Geologic map and sections of the Mayacmas quicksilver district, Sonoma, Lake, and Napa Counties, scale 1″ = 1 mi., price 50¢.

(d) Chapter 4, California Journal of Mines and Geology, October 1946, pp. 311-430, pls. 51-55, 4 figs. Price 60¢.

Contains: Current notes [Millspaugh iron deposit, Inyo County; Tiefort Mountains iron deposit, San Bernardino County], by W. B. Tucker, p. 319; The Map Information Office of the Geological Survey, by C. F. Feuchsel, pp. 321-324; Geology of the Kramer borate district, Kern County, California, by Hoyt S. Gale, pp. 325-378, pls. 51-55, 4 figs.; Salt, the most useful of mineral substances, by E. B. Tustin Jr., pp. 379-383; Index, pp. 421-430.

BEGINNING WITH VOLUME 43, NO. 1, THE *REPORTS OF THE STATE MINERALOGIST* ARE SUPERSEDED BY THE QUARTERLY SERIAL PUBLICATION *CALIFORNIA JOURNAL OF MINES AND GEOLOGY.*

CALIFORNIA JOURNAL OF MINES AND GEOLOGY (J)

(SUPERSEDES *REPORT OF THE STATE MINERALOGIST*)
Subscription price $3.00 per year (four issues)

*California Journal of Mines and Geology, volume 43. 1947. 502 pp., 43 pls., 1 map, 9 figs.

Issued also in separate parts, as indicated below.

(a) No. 1 (January), pp. 1-75, pls. 1-12, 1 fig. Price 75¢.

Contains: Walibu quicksilver mine, Kern County, California, by Edgar H. Bailey and C. Melvin Swinney, pp. 9-14, pls. 1-2, 1 fig.; Mines and mineral resources of Lake County, California, by Charles V. Averill, pp. 15-40, pls. 3-7; Mines and mineral resources of San Benito County, California, by Charles V. Averill, pp. 41-60, pls. 8-10; Condenser installation at the New Idria Quicksilver Mining Company, Idria, California, by Richard A. Crippen, Jr., pp. 61-62, pls. 11-12; Information in regard to mining claims on the public domain, pp. 63-66; Mineral patents, pp. 67-75.

The following is included with the report, or may be purchased alone: Map of Lake County, California, showing locations of principal mineral deposits, scale 1″ = 3 mi., price 25¢.

(b) No. 2 (April), pp. 79-162, pls. 13-20, 3 figs. Price 75¢.

Contains: Mines and mineral resources of Stanislaus County, California, by Abbott Charles, pp. 85-100, pls. 13-15; Vanadium, by W. B. Winston, pp. 101-104; Fifty years of operation by The Mountain Copper Company, Ltd., in Shasta County, California, by William F. Kett, pp. 105-162, pls. 16-19, 3 figs.

The following is included with report, or may be purchased alone: Map of Stanislaus County, California, showing locations of principal mineral deposits, scale ⅜″ = 1 mi., price 25¢.

(c) No. 3 (July), pp. 163-358, pls. 21-37, 2 figs., map. Price 75¢.

Contains: Status of topographic mapping in the United States, by the Map Information Office of the U. S. Geological Survey, pp. 169-173, map; Limestone in California, by Clarence A. Logan, pp. 175-357, pls. 21-37, 2 figs.

(d) No. 4 (October), pp. 359-502, pls. 38-43, 3 figs. Price 75¢.

Contains: Annual report, Division of Mines, for the ninety-eighth fiscal year, July 1, 1946 to June 30, 1947, by Olaf P. Jenkins, pp. 365-412, 3 figs; Mines and mineral resources of Siskiyou County, by J. C. O'Brien, pp. 413-462, pls. 38-43; Silver, by W. B. Winston, pp. 463-468; Pumice, by W. B. Winston, pp. 469-479; Index to volume 43, pp. 481-502.

The following is included with report, or may be obtained alone: * The mineral industry of California in 1947, compiled by Charles V. Averill and Olaf P. Jenkins (issued as preprint of part of Annual Report). Map of western portion, Siskiyou County, California, showing locations of mines and mineral deposits, scale 1″ = 3 mi. (approx.); and Map of eastern portion of Siskiyou County, California, showing locations of mineral deposits, scale 1″ = 3 mi.; price (set of two maps) 25¢.

*California Journal of Mines and Geology, volume 44. 1948. 524 pp., 59 pls., 27 figs., 4 charts.

Issued also in separate parts, as indicated below.

(a) No. 1 (January), pp. 1-122, pls. 1-9, 2 figs. Price 75¢.

Contains: Trends in the foundry-sand industry, by Leonard O. Hofstetter, pp. 7-8; Properties of foundry sands, by Heinrich Ries, pp. 9-35, pl. 1, 1 fig.; California foundry sands, by Lauren A. Wright, pp. 36-72, pls. 2-9, 1 fig.; Uranium, by W. B. Winston, pp. 73-92; Manner of locating and holding mineral claims in California, by A. H. Ricketts, pp. 93-122.

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* All publications marked with an asterisk (*) are out of print and cannot be obtained from the Division of Mines. Please do not send any money for publications so marked.

(b) No. 2 (April), pp. 123-242, pls. 10-39, charts 1-4. Price 75¢.

Contains: The basement complex in well samples from the Sacramento and San Joaquin Valleys, California, by J. C. May and R. L. Hewitt, pp. 129-158, pls. 10-17, charts 1-4; Mines and mineral resources of Napa County, California, by Fenelon F. Davis, pp. 159-188, pls. 18-22; Soda ash and saltcake in California, by Clarence R. King, pp. 189-200; The lakes of California, by William Morris Davis, pp. 201-242, pls. 24-39.

(c) No. 3 (July), pp. 243-320, pls. 40-51, 5 figs. Price 75¢.

Contains: Unusual concretions from Templeton, San Luis Obispo County, California, by R. A. Crippen, pp. 249-252, pls. 40-43; Quicksilver deposits of the Guerneville district, Sonoma County, California, by W. Bradley Myers and Donald L. Everhart, pp. 253-277, pls. 44-51, 5 figs.; Mining law in recent years, by William E. Colby (first of three articles), pp. 279-292; Pumice and perlite as industrial materials in California, by Clarence R. King, pp. 293-319.

(d) No. 4 (October), pp. 321-524, pls. 52-59, 20 figs. Price 75¢.

Contains: Economic aspects of mercury production in California, by C. R. King, pp. 327-334, 2 figs.; Current and recent mining activities in the Redding district, by J. C. O'Brien, pp. 335-378, pls. 52-55; The spectrograph and polarograph, by John Herman, pp. 379-409, pls. 56-59, 18 figs.; Public Resources Code, pp. 411-415; U. S. Atomic Energy Commission announces program to stimulate production of domestic uranium, pp. 417-425; Publications of the California State Division of Mines, by Elisabeth L. Egenhoff, Beth Collins, and Mary-Louise Burgess, pp. 427-516; Index to volume 44, pp. 517-524.

California Journal of Mines and Geology, volume 45. 1949. 590 pp., 26 pls., 11 figs.; Supplement, 128 pp., 71 illus. Price $6.50.

Issued also in separate parts, as indicated below.

(a) No. 1 (January), pp. 1-116, pls. 1-8, 4 figs. Price 75¢.

Contains: Annual report, Division of Mines, for the ninety-ninth fiscal year, July 1, 1947, to June 30, 1948, by Olaf P. Jenkins, pp. 7-29; Quicksilver deposits of the Oakville district, Napa County, California, by Philip F. Fix and C. Melvin Swinney, pp. 31-46, pls. 1-3, 2 figs.; Mines and mineral resources of Tuolumne County, California, by Clarence A. Logan, pp. 47-83, pls. 4-8; Barium, by W. B. Winston, pp. 85-97; Penn mine slag dump and mine water, Calaveras County, California, by Frank J. Wiebelt and Spangler Ricker, pp. 99-105, 2 figs.; Division of Mines publications issued September 1, 1948, to November 30, 1948, pp. 107-108; Map symbols used in publications of the U. S. Geological Survey, pp. 109-116.

The following is included with report, or may be obtained alone: Map of western third of Tuolumne County, California, showing mining claims and prospects, scale 1" = 1 mi. (approx.); price 25¢.

(b) No. 2 (April), pp. 117-358, pls. 9-18, 2 figs. Price 75¢.

Contains: Water-flooding as a method of increasing California oil production (Part 1, Factors influencing the application of water-flooding), by Wilbur H. Somerton, pp. 123-202, 1 fig.; Mineral resources of Kern County, California, by W. B. Tucker, R. J. Sampson, and G. B. Oakeshott, pp. 203-297, pls. 9-18, 1 fig.; State geological surveys, by Wilson M. Laird, pp. 299-317; Industrial uses of limestone and dolomite, by Oliver Bowles and Nan C. Jensen, pp. 319-334; An Act for the development and control of atomic energy, pp. 335-356; Division of Mines publications issued September 1, 1948, to February 15, 1949, p. 357.

The following are included with report, or may be obtained alone: Map of Kern County, California, showing locations of mines and prospects, scale 1¼" = 6 mi. (approx.); price 25¢. Map of western portion of Kern County, California, showing oil and gas fields and producing areas, scale 1" = 3 mi. (approx.); price 25¢.

(c) No. 3 (July), pp. 359-502, pls. 19-23, 3 figs. Price 75¢.

Contains: Water-flooding as a method of increasing California oil production (Part 2, A survey of California conditions relative to the application of water-flooding), by Wilbur H. Somerton, pp. 363-416; Mines and

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mineral resources of Butte County, California, by J. C. O'Brien, pp. 417-454, pls. 19-23; Roofing granules in the southwest, by Stuart H. Ingram, pp. 455-458; The western pulp and paper industry as a consumer of chemicals, by R. G. Mispley, pp. 459-464; Mining law in recent years, by William E. Colby (second of three articles), pp. 465-490; Ione-Carbondale clays, Amador County, California, by F. T. Johnson and Spangler Ricker, pp. 491-498, 3 figs.; Address of Governor Earl Warren to the American Institute of Mining and Metallurgical Engineers, Inc., San Francisco, California, February 14, 1949, pp. 499-502.

The following is included with report, or may be obtained separately: Map of Butte County showing location of mines and prospects, scale 1″ = 3 mi.; price 25¢.

(d) No. 4 (October), pp. 503-590, pls. 24-26, 2 figs.; supplement, 128 pp., 71 illus. Price $1.00.

Contains: Geology of limestone near Sonora, Tuolumne County, California, by George R. Heyl and John H. Wiese, pp. 509-513, pls. 24-25; Geology of limestone near Gazelle, Siskiyou County, California, by George R. Heyl and George W. Walker, pp. 514-520, pl. 26, 2 figs.; Minerals of California—supplement no. 1 to Bulletin 136, by Joseph Murdoch, pp. 521-540; Water-flooding as a method of increasing California oil production (Part 3, Current and proposed water-flooding research in California), by Wilbur H. Somerton, pp. 541-551; Materials of inorganic mineral origin used in the rubber industry, by Erle C. Zimmerman, pp. 553-561; Division of Mines publications issued May 1, 1949 to October 1, 1949, p. 562; Index to volume 45, pp. 563-590; Supplement, The elephant as they saw it, by Elisabeth L. Egenhoff, 128 pp., 71 illus.

The following is included with report, or may be obtained separately: The elephant as they saw it—a collection of contemporary pictures and statements on gold mining in California, assembled by Elisabeth L. Egenhoff as a centennial supplement to the California Journal of Mines and Geology for October 1949, 128 pp., 70 illus., colored frontispiece; price 75¢.

California Journal of Mines and Geology, volume 46. 1950. 526 pp., 78 pls., 33 figs.

Issued also in separate parts as indicated below.

(a) No. 1 (January), pp. 1-184, pls. 1-22, 12 figs. Price $1.00.

Contains: Submarine phosphorite deposits off California and Mexico, by K. O. Emery and R. S. Dietz, pp. 7-15, pls. 1-5; Geology along the Electra and West Point tunnels, Amador County, California, by John H. Wiese, Arvid A. Stromquist, John H. Eric, and C. Melvin Swinney, pp. 17-22, pl. 6, fig. 1; Geology and tungsten deposits of the Tungsten Hills, Inyo County, California, by Paul C. Bateman, Max P. Erickson, and Paul D. Proctor, pp. 23-42, pls. 7-13, 3 figs.; Geology of the Placerita oil field, Los Angeles County, California, by Gordon B. Oakeshott, pp. 43-79, pls. 14-21, 3 figs.; Perlite deposits in Sonoma County, California, by Charles W. Chesterman, pp. 81-82; Mines and mineral resources of Sonoma County, California, by Martin T. Honke Jr. and William E. Ver Planck Jr., pp. 83-141, pl. 22, 2 figs.; Annual report of the State Mineralogist, Chief of the Division of Mines for the One-Hundredth fiscal year, July 1, 1948 to June 30, 1949, by Olaf P. Jenkins, pp. 143-184, 3 figs.

The following is included with report, or may be obtained separately: Map showing mines and mineral deposits of Sonoma County, California, scale ½″ = 1 mi.; price 25¢.

(b) No. 2 (April), pp. 185-348, pls. 23-58, 12 figs.; supplement 31 pp. Price $1.00.

Contains: Geology and oil prospects of western San Jose Hills, Los Angeles County, California, by Franklin H. Olmsted, pp. 191-212, pls. 23-28, 2 figs.; Ironstone concretions and beach ridges of San Diego County, California, by K. O. Emery, pp. 213-221, pls. 29-33, 2 figs.; Geology of the Red Mountain magnesite district, Santa Clara and Stanislaus Counties, California, by Alfred J. Bodenlos, pp. 223-278, pls. 34-49, 7 figs.; Mines

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and mineral resources of Alameda County, by Fenelon F. Davis, pp. 279-346, pls. 50-58, 1 fig.; Supplement, Manner of locating and holding mineral claims in California, by A. H. Ricketts, revised by C. A. Logan and Charles V. Averill, 31 pp.

The following are included with report, or may be purchased separately: Manner of locating and holding mineral claims in California, by A. H. Ricketts, revised by C. A. Logan and Charles V. Averill, 31 pp.; price 25¢. Map of Alameda County, California, showing location of mines and mineral deposits, scale 1″ = 2 mi.; price 25¢.

(c) No. 3 (July), pp. 349-436, pls. 59-72, 6 figs. Price $1.00.

Contains: Needles magnesite deposit, San Bernardino County, California, by Charles J. Vitaliano, pp. 357-372, pls. 59-65, 2 figs.; Northern California as a market for chemicals, E. William Eipper, ed., pp. 373-384; Skaggs Springs quicksilver mine, Sonoma County, California, by Donald L. Everhart, pp. 385-394, pls. 66-69, 2 figs.; The Altoona quicksilver mine, Trinity County, California, by C. Melvin Swinney, pp. 395-404, pls. 70-71, 1 fig.; Health and safety work of the Bureau of Mines, by James Boyd, pp. 405-419; Mines and mineral resources of Yolo County, by J. C. O'Brien, pp. 421-436, pl. 72, 1 fig.

The following is included with report: Map showing mines and mineral deposits of Yolo County, California, scale ¼″ = 1 mi.

(d) No. 4 (October), pp. 437-562, pls. 73-78, 3 figs. Price $1.00.

Contains: Mines and mineral resources of Madera County, by C. A. Logan, pp. 445-482, pls. 73, 2 figs.; Mining law in recent years (third of three articles), by William E. Colby, pp. 483-508; Quicksilver deposits of the Cachuma district, Santa Barbara County, California, by Donald L. Everhart, pp. 509-532, pls. 74-78, 1 fig.; Index to volume 46, pp. 533-562.

The following is included with report, or may be purchased separately: Map of Madera County showing location of mines and mineral deposits, scale 1″ = 6 mi.; price 25¢.

California Journal of Mines and Geology, volume 47. 1951.

Issued also in separate parts as indicated below.

(a) No. 1 (January), pp. 1-223, pls. 1-18, 11 figs. Price $1.00.

Contains: Limestone in the California beet sugar industry, by F. H. Ballou Jr., pp. 9-16, 2 figs.; Mines and mineral resources of Inyo County, by L. A. Norman Jr. and Richard M. Stewart, pp. 17-223, pls. 1-18, 9 figs.

The following is included with report, or may be obtained separately: Map showing mines and mineral deposits of Inyo County, California, scale 1″ = 6 mi.; price 25¢.

(b) No. 2 (April), pp. 224-464, pls. 19-30, 3 figs.; supplement, 117 pp. Price $1.00.

Contains: Annual report of the State Mineralogist, Chief of the Division of Mines, for the 101st fiscal year, July 1, 1949 to June 30, 1950, by Olaf P. Jenkins, pp. 230-270, 3 figs.; Counties of California—mineral production and significant mining activities of 1949, prepared under the direction of Charles V. Averill and L. A. Norman Jr., contributing authors Charles V. Averill, James W. Crosby III, Fenelon F. Davis, George C. Hazenbush, L. A. Norman Jr., John C. O'Brien, Salem J. Rice, Richard M. Stewart, Henry H. Symons, Mort D. Turner, James W. Vernon, Lauren A. Wright, pp. 271-464, pls. 19-30; Supplement, Publications of the California State Division of Mines (to March 1, 1951), by Elisabeth L. Egenhoff, Beth Collins, and Mary-Louise Burgess, pp. 1-117.

The following is included with report, or may be obtained separately: Publications of the California State Division of Mines (to March 1, 1951), by Elisabeth L. Egenhoff, Beth Collins, and Mary-Louise Burgess, 117 pp. Free.

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BULLETINS (B)

*1. A description of the desiccated human remains in the California State Mining Bureau, by Winslow Anderson. 1888. 41 pp., 6 illus.

*2. Methods of mine-timbering, by W. H. Storms. 1896. 71 pp., 70 figs.

*3. The gas and petroleum yielding formations of the central valley of California, by W. L. Watts. 1894. 100 pp., 16 illus.

*4. Catalogue of California fossils, by J. G. Cooper. 1894. 65 pp., 6 pls.

*5. The cyanide process, its practical application and economical results, by A. Scheidel. 1894. 140 pp., 27 illus.

*6. California gold mill practices, by Ed B. Preston. 1895. 85 pp., 54 illus.

*7. Mineral production of California, by counties, for the year 1894, by Charles G. Yale. 1895. Tabulated sheet.

*8. Mineral production of California, by counties, for the year 1895, by Charles G. Yale. 1896. Tabulated sheet.

*9. Mine drainage, pumps, etc., by Hans C. Behr. 1896. 210 pp., 206 figs.

*10. A bibliography relating to the geology, palaeontology, and mineral resources of California, by Anthony W. Vodges. 1896. 121 pp.

*11. Oil and gas yielding formations of Los Angeles, Ventura, and Santa Barbara Counties, by W. L. Watts. 1897. 94 pp., 35 figs.

*12. Mineral production of California, by counties, for 1896, by Charles G. Yale. 1897. Tabulated sheet.

*13. Mineral production of California, by counties, for 1897, by Charles G. Yale. 1898. Tabulated sheet.

*14. Mineral production of California, by counties, for 1898, by Charles G. Yale. 1899. Tabulated sheet.

*15. Map of Oil City fields, Fresno County, by John H. Means. 1899.

*16. The genesis of petroleum and asphaltum in California, by A. S. Cooper. 1899. 89 pp., 29 figs.

*17. Mineral production of California, by counties, for 1899, by Charles G. Yale. 1900. Tabulated sheet.

*18. Mother Lode region of California, by W. H. Storms. 1900. 154 pp., 49 illus.

*19. Oil and gas yielding formations of California, by W. L. Watts. 1900. 236 pp., 74 illus.

*20. Synopsis of general report of the California State Mining Bureau, by W. L. Watts. 1901. 21 pp.

*21. Mineral production of California, by counties, by Charles G. Yale. 1900. Tabulated sheet.

*22. Mineral production of California for fourteen years, by Charles G. Yale. 1900. Tabulated sheet.

*23. The copper resources of California. 1902. 282 pp., 77 illus. The following was included with bulletin: * Map of California showing the approximate location of the principal copper deposits of the state. 1902.

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*24. The saline deposits of California, by Gilbert E. Bailey. 1902. 216 pp., 103 illus.

*25. Mineral production of California, by counties, for 1901, by Charles G. Yale. 1902. Tabulated sheet.

*26. Mineral production of California for the past fifteen years, by Charles G. Yale. 1902. Tabulated sheet.

*27. The quicksilver resources of California, by William Forstner. 1903. 273 pp., 152 illus.

*28. Mineral production of California for 1902, by Charles G. Yale. 1903. Tabulated sheet.

*29. Mineral production of California for sixteen years, by Charles G. Yale. 1903. Tabulated sheet.

*30. A bibliography relating to the geology, paleontology, and mineral resources of California, by Anthony W. Vodges. 1904. 290 pp., 6 illus.

*31. Chemical analysis of California petroleum, by H. N. Cooper. 1904. Tabulated sheet.

*32. Production and use of petroleum in California, by Paul W. Prutzman. 1904. 230 pp., 122 illus.

*33. Mineral production of California, by counties, for 1903, by Charles G. Yale. 1904. Tabulated sheet.

*34. Mineral production of California for seventeen years, by Charles G. Yale. 1904. Tabulated sheet.

*35. Mines and minerals of California, by Charles G. Yale. 1904. 55 pp., 26 illus.

*36. Gold dredging in California, by J. E. Doolittle. 1905. 120 pp., 69 illus.

*37. Gems, jewelers' materials, and ornamental stones of California, by George F. Kunz. 1905. 171 pp., 51 illus. . . . 2d ed. 1905. 171 pp., 51 illus., color pls. 1, 2, 3, 5.

*38. The structural and industrial materials of California. 1906. 412 pp., 150 illus.

*39. Mineral production of California, by counties, for 1904, by Charles G. Yale. 1905. Tabulated sheet.

*40. Mineral production of California for eighteen years, by Charles G. Yale. 1905. Tabulated sheet.

*41. Mines and minerals of California for 1904, by Charles G. Yale. 1905. 54 pp., 26 illus.

*42. Mineral production of California, by counties, for 1905, by Charles G. Yale. 1906. Tabulated sheet.

*43. Mineral production of California for nineteen years, by Charles G. Yale. 1906. Tabulated sheet.

*44. California mines and minerals, by Charles G. Yale. 1906. 54 pp., 26 illus.

*45. Auriferous black sands of California, by J. A. Edman. 1907. 19 pp., 5 illus.

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* All publications marked with an asterisk (*) are out of print and cannot be obtained from the Division of Mines. Please do not send any money for publications so marked.

46. General index to publications of the California State Mining Bureau, by Charles G. Yale. 1907. 54 pp., 5 illus. Price 25¢.

*47. Mineral production of California, by counties, for 1906, by Charles G. Yale. 1907. Tabulated sheet.

*48. Mineral production of California for twenty years, by Charles G. Yale. 1906. Tabulated sheet.

*49. Mines and minerals of California for 1906, by Charles G. Yale. 1907. 34 pp.

*50. The copper resources of California. 1908. 366 pp., 78 illus.

The following is included with bulletin: Map of California showing the approximate location of the principal copper deposits of the state. 1908.

*51. Mineral production of California, by counties, for 1907, by D. H. Walker. 1908. Tabulated sheet.

*52. Mineral production of California for twenty-one years, by D. H. Walker. 1907. Tabulated sheet.

*53. Mineral production of California, by Lewis E. Aubury. 1908. 84 pp., 23 illus.

*54. Mineral production of California, by counties, by D. H. Walker. 1908. Tabulated sheet.

*55. Mineral production of California for twenty-two years, by D. H. Walker. 1908. Tabulated sheet.

*56. Mineral productions, county maps and mining laws of California, by Lewis E. Aubury. 1909. 99 pp., 23 illus.

*57. Gold dredging in California, by Lewis E. Aubury, W. B. Winston, and Charles Janin. 1910. 305 pp., 249 illus.

*58. Mineral production of California, by counties, by D. H. Walker. 1909. Tabulated sheet.

*59. Mineral production of California for twenty-three years, by D. H. Walker. 1909. Tabulated sheet.

*60. Mineral productions, county maps and mining laws of California, by Lewis E. Aubury. 1910. 115 pp., 23 illus.

*61. Mineral production of California, by counties, for 1910, by D. H. Walker. 1911. Tabulated sheet.

*62. Mineral production of California for twenty-four years, by D. H. Walker. 1910. Tabulated sheet.

*63. Petroleum in southern California, by Paul W. Prutzman. 1913. 433 pp., 73 illus.

*64. Mineral production for 1911, by E. S. Boalich. 1912. 49 pp.

*65. Mineral production for 1912, by E. S. Boalich. 1913. 64 pp.

*66. Mining laws, United States and California, by F. McN Hamilton. 1914. 89 pp.

*67. Minerals of California, by Arthur S. Eakle. 1914. 226 pp.

*68. Mineral production for 1913, by E. S. Boalich. 1914. 158 pp., 21 illus.

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* All publications marked with an asterisk (*) are out of print and cannot be obtained from the Division of Mines. Please do not send any money for publications so marked.

*69. Petroleum industry of California, by R. P. McLaughlin. 1915. 519 pp., 109 illus., 18 pls. in accompanying folio.

*70. Mineral production for 1914 with mining law appendix, by Fletcher Hamilton. 1915. 184 pp., 21 illus.

*71. California mineral production for 1915 with mining law appendix and county maps, by Walter W. Bradley. 1916. 193 pp., 25 illus.

*72. The geologic formations of California, with reconnaissance geologic map (scale 1″ = 12 mi.), by James Perrin Smith. 1916. 47 pp.

*73. First annual report of the State Oil and Gas Supervisor of California for the fiscal year 1915-16, covering operations of the Department of Petroleum and Gas of the State Mining Bureau, by R. P. McLaughlin. 1917. 278 pp., 66 illus.

*74. California mineral production for 1916 with county maps, by Walter W. Bradley. 1917. 179 pp., 34 illus.

*75. Mining laws, United States and California, compiled by Fletcher Hamilton. 1917. 115 pp.

76. Manganese and chromium in California, by Walter W. Bradley, Emile Huguenin, C. A. Logan, W. Burling Tucker, and Clarence A. Waring. 1918. 248 pp., 56 illus. Price 75¢.

77. Catalogue of the publications of the California State Mining Bureau, 1880-1917, by E. S. Boalich. 1918. 44p. Price 25¢.

*78. Quicksilver resources of California, with a section on metallurgy and ore-dressing, by Walter W. Bradley. 1918. 389 pp., 119 illus.

79. Magnesite in California, by Walter W. Bradley. 1925. 147 pp., 73 illus. Price $1.25.

80. Not issued.

81. Not issued.

*82. Second annual report of the State Oil and Gas Supervisor of California for the fiscal year 1916-1917 covering operations of the Department of Petroleum and Gas of the State Mining Bureau, by R. P. McLaughlin. 1918. 412 pp., 87 illus.

83. California mineral production for 1917 with county maps, by Walter W. Bradley. 1918. 179 pp., 32 illus. Price 25¢.

*84. Third annual report of the State Oil and Gas Supervisor of California for the fiscal year 1917-1918 covering operations of the Department of Petroleum and Gas of the State Mining Bureau, by R. P. McLaughlin. 1918. 617 pp., 88 illus.

*85. Platinum and allied metals in California, by C. A. Logan. 1919. 120 pp., 14 illus.

*86. California mineral production for 1918 with county maps, by Walter W. Bradley. 1919. 212 pp., 47 illus.

*87. The commercial minerals of California, with notes on their uses, distribution, properties, ores, field tests, and preparation for market, by W. O. Castello. 1920. 124 pp.

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* All publications marked with an asterisk (*) are out of print and cannot be obtained from the Division of Mines. Please do not send any money for publications so marked.

88. California mineral production for 1919 with county maps, by Walter W. Bradley. 1920. 204 pp., 50 illus. Price 25¢.

*89. Petroleum resources of California with special reference to unproved areas, by Lawrence Vander Leck. 1921. 186 pp., 25 illus.

Contains: Map of California showing generalized classification of land with regard to oil possibilities, scale 1½" = 50 mi.

*90. California mineral production for 1920 with county maps, by Walter W. Bradley. 1921. 218 pp., 46 illus.

*91. Minerals of California, by Arthur S. Eakle. 1923. 328 pp.

*92. Gold placers of California, by Charles Scott Haley. 1923. 167 pp., 43 illus.

Contains: Topographic map of Sierra Nevada gold belt showing distribution of the auriferous gravels, scale 1" = 4 mi.

*93. California mineral production for 1922, by Walter W. Bradley. 1923. 188 pp., 12 illus.

*94. California mineral production for 1923, by Walter W. Bradley. 1924. 162 pp., 7 illus.

*95. Geology and ore deposits of the Randsburg quadrangle, California, by Carlton D. Hulin. 1925. 152 pp., ix pp., 39 illus.

*96. California mineral production for 1924, by Walter W. Bradley. 1925. 174 pp., 12 illus.

*97. California mineral production for 1925, by Walter W. Bradley. 1926. 172 pp., 10 illus.

*98. American mining law, with forms and precedents, by A. H. Ricketts. 1931. 811 pp., 20 illus.

99. The clay resources and the ceramic industry of California, by Waldemar Fenn Dietrich. 1928. 383 pp., 82 illus. Price $2.00.

*100. California mineral production for 1926, by Walter W. Bradley. 1927. 175 pp., 8 illus.

101. California mineral production for 1927, by Henry H. Symons. 1928. 311 pp., 6 illus. Price 25¢.

102. California mineral production for 1928, by Henry H. Symons. 1929. 215 pp. 14 illus. Price 25¢.

*103. California mineral production for 1929, by Henry H. Symons. 1930. 231 pp., 11 illus.

104. Bibliography of the geology and mineral resources of California to December 31, 1930, by Solon Shedd. 1933. 376 pp., xi pp., 14 illus. Price $2.50.

*105. California mineral production and directory of mineral producers for 1930, by Henry H. Symons. 1931. 231 pp., 7 illus.

*106. Manner of locating and holding mineral claims in California, by A. H. Ricketts. 1939. 26 pp.

107. California mineral production and directory of mineral producers for 1931, by Henry H. Symons. 1932. 229 pp., 10 illus. Price 25¢.

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* All publications marked with an asterisk (*) are out of print and cannot be obtained from the Division of Mines. Please do not send any money for publications so marked.

*108. Mother Lode gold belt of California, by Clarence A. Logan. 1935. 240 pp., 43 illus.

The following are included with bulletin, or may be obtained alone: Geologic map of Mother Lode belt and vicinity, prepared by Olaf P. Jenkins, scale 1" = 18 mi., price 25¢; Map of Mother Lode gold belt in Amador County showing mining claims and areal geology, scale 1" = 1 mi., price 25¢; Map of Mother Lode gold belt in Calaveras County showing mining claims and areal geology, scale 1" = 1 mi., price 25¢; Map of Mother Lode gold belt in El Dorado County showing mining claims and areal geology, scale 1" = 1 mi., price 25¢; Map of Mother Lode gold belt in Mariposa County showing mining claims and areal geology, scale 1" = 1 mi., price 25¢.

109. California mineral production and directory of mineral producers for 1932, by Henry H. Symons. 1933. 200 pp., 10 illus. Price 25¢.

110. California mineral production and directory of mineral producers for 1933, by Henry H. Symons. 1934. 214 pp., 13 illus. Price 25¢.

111. California mineral production and directory of mineral producers for 1934, by Henry H. Symons. 1935. 334 pp., 12 illus. Price 25¢.

112. California mineral production and directory of mineral producers for 1935, by Henry H. Symons. 1937. 205 pp., 6 illus. Price 25¢.

*113. Minerals of California, by Adolf Pabst. 1938. 344 pp., xv pp., 1 illus.

114. California mineral production and directory of mineral producers for 1936, by Henry H. Symons. 1937. 199 pp., 5 illus. Price 25¢.

115. Bibliography of the geology and mineral resources of California for the years 1931 to 1936, inclusive (supplementing the master bibliography, Bulletin 104), by Solon Shedd. 1937. 125 pp., xiv pp. Cloth-bound, $1.25.

116. California mineral production and directory of mineral producers for 1937, by Henry H. Symons. 1938. 202 pp., 6 illus. Price 25¢.

117. California mineral production and directory of mineral producers for 1938, by Henry H. Symons. 1939. 216 pp., 8 illus. Price 25¢.

118. Geologic formations and economic development of the oil and gas fields of California, prepared under the direction of Olaf P. Jenkins. * 1st ed., 1943. 2d ed., 1949. 773 pp., 6 pls., 1 map, 81 index maps, 296 figs. Price $6.00.

Contains:

(a) Part 1, Development of the industry, pp. 1-80, pl. 1, figs. 1-35, containing the following chapters: *Chapter 1, Development and production, pp. 2-36, pl. 1, figs. 1-13, composed of* Economics of the oil and gas industry of California, by J. R. Pemberton, pp. 3-14, figs. 1-2; Taxation and its relation to development and production, by Granville S. Borden, pp. 15-16; Historical production chart, by H. L. Scarborough, pp. 16-17, pl. 1; Stocks, shipments, and production charts, by H. L. Scarborough, pp. 17-19, figs. 3-4b; Significant statistics, by Wm. R. Wardner Jr., pp. 20-25; Analysis of California petroleum reserves and their relation to demand and curtailment, by Wm. R. Wardner Jr., pp. 26-32, figs. 5-11; Natural gas fields of California, by Roy M. Bauer and John F. Dodge, pp. 33-36, figs. 12-13. *Chapter 2, Exploration, pp. 37-72, figs. 13A-33E, composed of* Outline map of portion of California showing location of oil fields and districts, by R. D. Bush, p. 38, fig. 13A; Development of engineering technique and its effect upon exploration for oil and gas in California, by

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Lester C. Uren, pp. 39-62, figs. 14-27B; Mechanics of California reservoirs, by Stanley C. Herold, pp. 63-66, figs. 28-31; Geophysical studies in California, by F. E. Vaughan, pp. 67-70, fig. 32; Geochemical prospecting for petroleum, by E. E. Rosaire, pp. 71-72, figs. 33A-E. *Chapter 3, Early history, pp. 73-80, figs. 33F-35, composed of* Aboriginal use of bitumen by the California Indians, by Robert F. Heizer, p. 74, fig. 34; History of exploration and development of gas and oil in northern California, by Walter Stalder, pp. 75-80, fig. 35.

(b) Part 2, Geology of California and the occurrence of oil and gas, pp. 81-276, pls. 2-6, figs. 36-115, containing the following chapters: *Chapter 4, Introduction to the geology, pp. 82-97, 1 map, figs. 36-45, composed of* Geomorphic provinces of California, by Olaf P. Jenkins, pp. 83-88, figs. 36-38; California relief map, 1930, showing geomorphic provinces, by H. A. Sedelmeyer, p. 84, fig. 36; Salient geologic events in California and their relationship to mineral deposition, by Olaf P. Jenkins, pp. 89-94, figs. 39-43; Position of the California oil fields as related to geologic structure, by Ralph D. Reed, pp. 95-97, figs. 44-45. *Chapter 5, Geologic history and structure, pp. 98-163, pl. 2, figs. 46-59B composed of* California's record in the geologic history of the world, by Ralph D. Reed, pp. 99-118, figs. 46-55; Geologic history and structure of the central Coast Ranges of California, by N. L. Taliaferro, pp. 119-163, figs. 56-59B, pl. 2. *Chapter 6, Paleontology and stratigraphy, pp. 164-207, pls. 3-4, figs. 60-87B composed of* Characteristic fossils of California, by G. Dallas Hanna and Leo George Hertlein, pp. 165-182, figs. 60-67; Descriptions of foraminifera, by C. C. Church, p. 182; Synopsis of the later Mesozoic in California, by Frank M. Anderson, pp. 183-186, figs. 68-71; Notes on Tertiary correlation, by Bruce L. Clark, pp. 187-191, fig. 72; Index to township and range system of California, p. 192, fig. 73; Eocene formaminiferal correlations in California, by Boris Laiming, pp. 193-198, figs. 74-83; Sequence of Oligocene formations of California, by Lesh C. Forrest, pp. 199-200, pl. 3, fig. 84; Correlation chart of the Miocene of California, by Robert M. Kleinpell, p. 200, pl. 4; Pliocene correlation chart, by U. S. Grant IV and Leo George Hertlein, pp. 201-202, fig. 85; The Pleistocene in California, by J. E. Eaton, pp. 203-207, figs. 86-87B. *Chapter 7, Occurrence of oil, pp. 208-276, pls. 5-6, figs. 88-115 composed of* Stratigraphic formations of the producing zones of the Los Angeles Basin oil fields, by Stanley G. Wissler, pp. 209-234, figs. 88-94, pl. 5; Correlation of the oil fields of the Santa Maria district, by Stanley G. Wissler and Frank E. Dreyer, pp. 235-238, fig. 95; Correlation of oil field formations on east side San Joaquin Valley, by Glenn C. Ferguson, pp. 239-246, figs. 96A-98; Correlation of oil field formations on west side of San Joaquin Valley, by Paul P. Goudkoff, pp. 247-252, figs. 99A-101; Origin, migration and accumulation of oil in California, by Harold W. Hoots, pp. 253-276, pl. 6, figs. 102-115.

The following is included with bulletin: Index map of the economic minerals in California (showing also geomorphic provinces) scale 1″ = 80 mi. Free.

(c) Part 3, Descriptions of individual oil and gas fields, pp. 277-664, 81 index maps, figs. 116, 282, containing Citations to selected references, by Elisabeth L. Egenhoff, pp. 278 et seq. throughout Part 3, Index maps 101-122, 201-217, 301-307, 401-432, 501-503. *Chapter 8, Los Angeles Basin and southernmost California, pp. 281-369, figs. 116-152 composed of* Los Angeles City oil field, by E. K. Soper, pp. 282-283, fig. 116; Salt Lake oil field, by E. K. Soper, pp. 284-286, fig. 117; Beverly Hills oil field, by E. K. Soper, p. 287, fig. 118; Whittier oil field, by W. H. Holman, pp. 288-291, figs. 119-121; Playa del Rey oil field, by Loyde H. Metzner, pp. 292-294, fig. 123; El Segundo oil field, by Richard G. Reese, pp. 295-296, fig. 124; Lawndale oil field, by Richard G. Reese, p. 297; Torrance oil field, by Eugene L. Davis, pp. 298-300, fig. 125; Wilmington oil field, by Read Winterburn, pp. 301-305, figs. 126-127; Inglewood oil field, by Herschel L. Driver, pp. 306-309, fig. 128; Potrero oil field, by Robin Willis and Richard S. Ballantyne Jr., pp. 310-317, figs. 129-131; Dominguez oil field,

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by S. Grinsfelder, pp. 318-319, fig. 132; Long Beach oil field, by Harry P. Stolz, pp. 320-324, figs. 133-134; Seal Beach oil field, by Glenn H. Bowes, pp. 325-328, figs. 135-137; Huntington Beach oil field, by D. K. Weaver and V. H. Wilhelm, pp. 329-331, fig. 138; Newport oil field, by Frank S. Parker, pp. 332-334, fig. 139; West Montebello area of the Montebello oil field, by Harry P. Stolz and A. F. Woodward, pp. 335-339, fig. 140; Montebello area of the Montebello oil field, by Richard G. Reese, pp. 340-342, fig. 141; Santa Fe Springs oil field, by H. E. Winter, pp. 343-346, fig. 142; West Coyote area of the Coyote Hills oil field, by Richard G. Reese, pp. 347-348; East Coyote area of the Coyote Hills oil field, by Paul H. Dudley, pp. 349-354, figs. 143-146; Yorba Linda area of the Coyote Hills oil field, by Frank S. Parker, pp. 355-356, fig. 147; Richfield area of the Richfield oil field, by Chester M. Gardiner, pp. 357-360, figs. 148-149; Kraemer area of the Richfield oil field, by Richard G. Reese, p. 361; Chino area, by Max L. Krueger, pp. 362-363, fig. 150; Cretaceous formations of the northern Santa Ana Mountains, by W. P. Popenoe, pp. 364-366, fig. 151; Southwestern San Diego County, by Leo George Hertlein and U. S. Grant IV, pp. 367-369, fig. 152. *Chapter 9, Ventura Basin and Transverse Ranges, pp. 370-424, figs. 153-176, composed of* Gaviota-Concepcion area, by William W. Porter II, pp. 372-373; Capitan oil field, by George R. Kribbs, pp. 374-376, figs. 153-154; Goleta oil field, by Frederick P. Vickery, pp. 377-379, fig. 155; Elwood oil field, by Mason L. Hill, pp. 380-383, figs. 156-157; La Goleta gas field, by R. O. Swayze, pp. 384-385, fig. 158; Summerland oil field, by Emil Kluth, p. 386; Rincon oil field, by R. E. Stewart, pp. 387-389, fig. 159; Ventura Avenue oil field, by C. C. Thoms and Wm. C. Bailey, pp. 391-393, fig. 160; Santa Paula oil field, by Louis N. Waterfall, p. 394, fig. 161; Sespe oil field, by Thomas Clements, pp. 395-399, fig. 162; Piru oil field, by H. D. Hobson, pp. 400-403, figs. 163-165; South Mountain oil field, by Loring B. Snedden, pp. 404-405, fig. 166; Bardsdale area of the Bardsdale oil field, by Loring B. Snedden, p. 406; Shiells Canyon area of the Bardsdale oil field, by Loring B. Snedden, p. 407; Del Valle oil field, by R. W. Sherman, pp. 408-411, figs. 167-169; Newhall oil field, by W. S. W. Kew, pp. 412-416, figs. 170-171; Simi oil field, by T. F. Stipp, pp. 417-423, figs. 172-176; Conejo oil field, by John C. May, p. 424. *Chapter 10, Santa Maria Basin and southern Coast Ranges, pp. 425-481, figs. 177-202 composed of* Lompoc oil field, by T. W. Dibblee Jr., pp. 427-429, fig. 177; Casmalia oil field, by William W. Porter II, p. 430; Santa Maria (Orcutt) oil field, by F. E. Dreyer, p. 431; West Cat Canyon area of the Cat Canyon oil field, by Charles Manlove, pp. 432-434, fig. 178; East Cat Canyon area of the Cat Canyon oil field, by Rodman K. Cross, pp. 435-437, figs. 179-180; Gato Ridge area of the Cat Canyon oil field, by Rodman K. Cross, pp. 438-439, fig. 181; Santa Maria Valley oil field, by Charles R. Canfield, pp. 440-442, figs. 182-183; Geology of Huasna area, by N. L. Taliaferro, pp. 443-447, figs. 184-185; Huasna area development, by Vernon L. King, pp. 448-449; Arroyo Grande (Edna) oil field, by Max L. Krueger, pp. 450-452, fig. 186; Caliente Range, Cuyama Valley, and Carrizo Plain, by J. E. Eaton, pp. 453-455, figs. 187-188; Bradley-San Miguel district, by N. L. Taliaferro, pp. 456-462, fig. 189; Type locality of the Vaqueros formation, by Richard R. Thorup, pp. 463-466, figs. 190-192; Soledad quadrangle, by L. F. Schombel, pp. 467-470, figs. 193-195; Cantua-Vallecitos area, by E. R. Atwill, pp. 471-474, figs. 196-199; Sargent oil field, by James Michelin, pp. 475-476, fig. 200; Moody Gulch oil field, by Max L. Krueger, p. 477, fig. 201; Halfmoon Bay district, by Richard R. Crandall, pp. 478-480, fig. 202; Mount Diablo region, by Charles M. Cross, p. 481. *Chapter 11, San Joaquin Valley and bordering foothills, pp. 482-583, figs. 203-258, composed of* Geologic horizons of oil and gas fields of San Joaquin Valley and farther north, by Paul J. Howard, p. 483, fig. 203; Coalinga oil field, by Max Birkhauser, pp. 484-485, fig. 204; Coalinga East Extension area of the Coalinga oil field, by L. S. Chambers, pp. 486-490, figs. 205-207; Kettleman Hills oil fields, by John Galloway, pp. 491-493, fig. 208; Lost Hills oil field, by G. S. Follansbee Jr., pp. 494-495, figs. 209-210; Devils

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Den oil field, by Martin Van Couvering and H. B. Allen, pp. 496-501, figs. 211-213; Belridge oil field, by J. B. Wharton, pp. 502-504; Temblor oil field, by R. R. Simonson, pp. 505-506, fig. 214; McKittrick Front and Cymric areas of the McKittrick oil field, by E. R. Atwill, pp. 507-509, figs. 215-216; McKittrick area of the McKittrick oil field, by John B. Stevens, pp. 510-511, fig. 217; Elk Hills oil field (U. S. Naval Petroleum Reserve No. 1), by Lawrence E. Porter, pp. 512-516, figs. 218-220; Buena Vista Hills area of the Midway-Sunset oil field, by J. H. McMasters, pp. 517-518, fig. 221; North Midway area of the Midway Sunset oil field, by W. T. Woodward, pp. 519-521, figs. 222-223; Republic area of the Midway-Sunset oil field, by Umberto Young, pp. 522-525, fig. 224; Williams and Twenty-five Hill areas of the Midway-Sunset oil field, by Donuil Hillis and W. T. Woodward, pp. 526-529, figs. 225-228; Gibson area of the Midway-Sunset oil field, by W. T. Woodward, pp. 530-531, figs. 229-230; Wheeler Ridge oil field, by S. H. Gester, pp. 532-533, fig. 231; Type locality of the Tejon formation, by Jay Glenn Marks, pp. 534-538, figs. 232-233; Dudley Ridge gas field, by Gerard Henny, pp. 539-540, fig. 234; Semitropic gas field, by W. W. Valentine, p. 542, fig. 235; Buttonwillow gas field, by L. S. Chambers, pp. 543-545, figs. 236-237; Canal oil field, by R. N. Williams Jr., pp. 546-547, fig. 238; Strand oil field, by Charles M. Cross, p. 548, fig. 239; Ten Section oil field, by A. W. Gentry, pp. 549-550, fig. 240; Trico gas field, by E. C. Doell, pp. 551-552, figs. 241-242; Wasco oil field, by Roy M. Barnes, pp. 553-555, fig. 243; Rio Bravo oil field, by Earl B. Noble, pp. 556-558, fig. 244; Greeley oil field, by W. P. Winham, pp. 559-561, figs. 245-246; Fruitvale oil field, by Robert H. Miller and Glen W. Ledingham, pp. 562-564, fig. 247; Mountain View oil field, by Robert H. Miller and Glenn C. Ferguson, pp. 565-570, fig. 248; Kern Front area of the Kern River oil field, by Everett C. Edwards, pp. 571-574, figs. 249-252; Kern River area of the Kern River oil field, by John B. Stevens, p. 575, fig. 253; Edison oil field, by Everett C. Edwards, pp. 576-578, figs. 254-255; Round Mountain oil field, by R. G. Rogers, pp. 579-583, figs. 256-258; *Chapter 12, Northern San Joaquin Valley, Sacramento Valley, and northern Coast Ranges, pp. 584-635, figs. 259-282, composed of* Tracy gas field, by H. T. Beckwith, pp. 586-587, fig. 259; McDonald Island gas field, by George L. Knox, pp. 588-590, fig. 260; Rio Vista gas field, by E. K. Soper, pp. 591-594, fig. 261; Potrero Hills gas field, by Frank B. Tolman, pp. 595-598, figs. 262-263; Fairfield Knolls gas field, by J. M. Kirby, pp. 599-600, fig. 264; Rumsey Hills area, by J. M. Kirby, pp. 601-605, figs. 265-266; Sites region, by J. M. Kirby, pp. 606-608, figs. 267-268; Willows gas field, by R. N. Williams Jr., p. 609, fig. 269; Marysville Buttes (Sutter Buttes) gas field, by Harry R. Johnson, pp. 610-615, figs. 270-271; Berryessa Valley, by F. M. Anderson, pp. 616-618, fig. 272; Paskenta region, by Robert L. Rist and William C. Harrington, pp. 619-620, figs. 273-274; Duxbury Point region, by James M. Douglas, p. 621, fig. 275; Petaluma region, by F. A. Johnson, pp. 622-627, figs. 276-279; Point Arena-Fort Ross region, by Charles E. Weaver, pp. 628-632, fig. 280; Central and southern Humboldt County, by Harry D. MacGinitie, pp. 633-635, figs. 281-282. *Chapter 13, Tabulated data on wells drilled outside of the principal oil and gas fields, pp. 636-664.*

Part 4, Glossaries, bibliography, and index, pp. 665-773, figs. 283-284, containing the following chapters: *Chapter 14, Glossary of the geologic units of California, compilation based largely on the work of M. Grace Wilmarth and Alice S. Allen, abstracted and revised by Olaf P. Jenkins, pp. 666-687, figs. 283-284. Chapter 15, Bibliography, pp. 688-720,* List of publications cited throughout Bulletin 118, by Elisabeth L. Egenhoff, pp. 689-720. *Chapter 16, Index to Bulletin 118, by Elisabeth L. Egenhoff, pp. 722-773.*

The following is included with report, or may be purchased alone: Outline geologic map of California showing oil and gas fields and drilled areas (Economic mineral map of California no. 2—Oil and gas), scale 1:1,000,000, by Olaf P. Jenkins. 1941. Price $1.00.

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119. California mineral production and directory of mineral producers for 1939, by Henry H. Symons. 1941. 223 pp., 8 illus. Price 25¢.

*120. Manner of locating and holding mineral claims in California, by A. H. Ricketts (with revisions by C. McK Laizure, August 1941). 1941. 26 pp.

121. California mineral production and directory of mineral producers for 1940, by Henry H. Symons. 1941. 227 pp., 12 illus. Price 25¢.

122. California mineral production and directory of mineral producers for 1941, by Henry H. Symons. 1942. 377 pp., 8 figs. Price 25¢.

123. American mining law, with forms and precedents, by A. H. Ricketts. * 1st ed., 1943. 1018, xvi pp. 2d ed., 1949. Vol. 1, pp. i-xxxi, 1-618; vol. 2, pp. 619-1018. Price (vols. 1 and 2) $3.00.

*124. Commercial minerals of California, by George L. Gary. 1942. 166 pp., mimeographed.

125. Manganese in California, prepared under the direction of Olaf P. Jenkins. 1943. 387 pp., 1 map, 46 figs. Cloth-bound, price $3.00.

Contains: Preface, by Olaf P. Jenkins, pp. 9-12; History of the manganese industry, by Robert Scott Kroger, pp. 13-21; Occurrence and minerals of manganese, by Theo H. Crook, pp. 23-40; Utilization of California manganese ores, by O. Cutler Shepard, pp. 41-49, 2 figs.; Manganese deposits of California, a summary report, by Parker D. Trask, Ivan F. Wilson, and Frank S. Simons, pp. 51-215, 2 figs.; Genesis of the manganese deposits of the Coast Ranges of California, by N. L. Taliaferro and F. S. Hudson, pp. 217-275, 22 figs.; Manganese deposits of the Sierra Nevada, their genesis and metamorphism, by N. L. Taliaferro, pp. 277-332, 20 figs.

The following is included with bulletin, or may be purchased alone: Outline geologic map of California showing locations of manganese properties (Economic mineral map No. 5—Manganese), by Olaf P. Jenkins, scale 1:1,000,000. Price, 60¢.

126. California mineral production and directory of mineral producers for 1942, by Henry H. Symons. 1943. 224 pp., 7 illus. Price 25¢.

*127. Manner of locating and holding mineral claims in California, by A. H. Ricketts (with revisions by C. A. Logan, March 1944). 1944. 35 pp.

128. California mineral production and directory of mineral producers for 1943, by Henry H. Symons. 1944. 222 pp., 10 illus. Price 25¢.

129. Iron resources of California, prepared under the direction of Olaf P. Jenkins. 1948. 304 pp., 25 pls., 68 figs. Price $2.50.

Contains: Preface, by Olaf P. Jenkins, pp. ix-xii; Parts A-P, see below; Bibliography of the iron-ore resources of California, by Elisabeth L. Egenhoff, pp. 269-300; Index, pp. 302-304.

Issued also in separate parts, as indicated below; price, each, 25¢.

(a) Iron-ore deposits in the eastern part of the Eagle Mountains, Riverside County, California, by Jarvis B. Hadley, pp. 1-24, pls. 1-3, figs. 1-11.

(b) Iron Mountain iron-ore deposits, Lava Bed district, San Bernardino County, California, by Carl A. Lamey, pp. 25-38, pl. 4, figs. 12-15.

(c) Iron Mountain and Iron King iron-ore deposits, Silver Lake district, San Bernardino County, California, by Carl A. Lamey, pp. 39-58, pls. 5-7, figs. 16-19.

(d) Old Dad Mountain iron-ore deposit, San Bernardino County, California, by Carl A. Lamey, pp. 59-68, figs. 20-22.

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(e) Cave Canyon iron-ore deposits, San Bernardino County, California, by Carl A. Lamey, pp. 69-84, pl. 8, figs. 23-29.

(f) Vulcan iron-ore deposit, San Bernardino County, California, by Carl A. Lamey, pp. 85-96, pl. 9, figs. 30-33.

(g) Iron Hat (Ironclad) iron-ore deposits, San Bernardino County, California, by Carl A. Lamey, pp. 97-109, pl. 10, figs. 34-37.

(h) Ship Mountains iron-ore deposit, San Bernardino County, California, by Carl A. Lamey, pp. 110-116, pls. 11-12, fig. 38.

(i) Minarets magnetite deposits of Iron Mountain, Madera County, California, by Parker D. Trask and Frank S. Simons, pp. 117-128, pl. 13, figs. 39-43.

(j) Hirz Mountain iron-ore deposits, Shasta County, California, by Carl A. Lamey, pp. 129-136, pls. 14-16, fig. 44.

(k) Shasta and California iron-ore deposits, Shasta County, California, by Carl A. Lamey, pp. 137-164, pls. 17-19, figs. 45-53.

*(l) Iron-ore deposits near Lake Hawley and Spencer Lakes, Sierra County, California, by Cordell Durrell and Paul D. Proctor, pp. 165-192, pls. 20-23, figs. 54-57.

*(m) Iron deposits of the Kingston Range, San Bernardino County, California, by D. F. Hewett, pp. 193-206, pl. 24, fig. 58.

*(n) Summary of the iron-ore situation in California, by Ernest F. Burchard, pp. 207-230, figs. 59-64.

*(o) Summary of investigations of iron-ore deposits of California, by A. C. Johnson and Spangler Ricker, pp. 231-242.

*(p) Titaniferous iron-ore deposits of the western San Gabriel Mountains, Los Angeles County, California, by Gordon B. Oakeshott, pp. 243-266, pl. 25, figs. 65-68.

130. Economic mineral resources and production of California; A survey with reference to postwar employment, by Samuel H. Dolbear. 1945. 219 pp., pp. A1-56, B1-146, C1-23, Index pp. 1-14, 3 maps. Price, $1.00.

Contains: Preface, by Samuel H. Dolbear, pp. 7-8; Summary, pp. 9-10; Place and function of minerals in the state's economy, pp. 11-25; California mineral reserves, pp. 26-30, 1 map; Employment in California mineral industries, by S. R. Coghlan, pp. 31-41; Legislative and other control in mineral industry, pp. 42-43; Needed changes in California statutory and administrative law, by Robert M. Searls, pp. 44-46; Needed changes in federal statutory and administrative law, by Philip R. Bradley Jr., pp. 47-54; Possible expansion of California mineral industries, pp. 55-59; The chemical industry as consumer of California minerals, by Herbert Waterman, pp. 60-70; Postwar construction and new equipment projects, pp. 70-71; National mineral policy, pp. 72-73. Commercial minerals of California, pp. 74-219, includes: Aluminum, pp. 75-76; Antimony, p. 76; Asbestos, pp. 77-78; Barite, pp. 78-80; Bentonite and fullers earth, pp. 80-82; Bituminous rock, pp. 82-83; Borates, pp. 83-86; Bromine, pp. 86-87; Building stone, pp. 87-89; Calcium chloride, p. 90; Calcium silicate, p. 90; Carbon dioxide gas, p. 91; Cement, pp. 92-97; Chromite, pp. 97-100; Clay and clay products, by J. Clark Sutherland, pp. 100-106; Coal, p. 107; Copper, lead, and zinc, by Hadley R. Bramel, pp. 107-118; Diatomite, pp. 118-120; Feldspar, pp. 120-121; Garnet (abrasive), pp. 121-122; Gold, by G. A. Joslin, pp. 122-151; Gypsum, pp. 151-155; Iodine, p. 155; Iron and steel, by H. Foster Bain, pp. 155-165; Lime, limestone, and dolomite, by Roy E. Tremoureux, pp. 165-169; Lithium, pp. 169-171; Magnesite and magnesium compounds, by S. R. Coghlan, pp. 171-174; Magnesium, pp. 175-176; Manganese, pp. 176-179; Mineral water, p. 180; Minor minerals, pp. 181-182; Molybdenum, pp. 182-183; Platinum, p. 184; Potash, pp. 184-186; Pumice, pp. 187-189; Pyrites, pp. 189-190; Quicksilver, pp. 191-196; Salt, by Walter W. Bradley, pp. 196-199; Semi-precious stones and crystals, p. 199; Silica, pp. 199-201; Sillimanite group, pp. 202-204; Soda

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* All publications marked with an asterisk (*) are out of print and cannot be obtained from the Division of Mines. Please do not send any money for publications so marked.

ash-salt cake, pp. 204-207; Stone, miscellaneous, pp. 207-210; Strontium, p. 210; Sulphur, pp. 210-211; Talc and steatite, by J. Clark Sutherland, pp. 211-215; Tungsten, pp. 215-219. Appendix A: Directory of producers, pp. A1-56; Appendix B: Mineral production by counties, pp. B1-146; Appendix C, pp. C1-23 includes Public Resources Code, pp. C1-4; and Publications of the Division of Mines, pp. C5-23. Index, pp. 1-14.

The following are included with bulletin: Map of California showing progress in topographic quadrangles and geologic maps, scale 1" = 40 mi. (approx.); and Map of California showing distribution of mineral deposits, scale 1" = 40 mi. (approx.); prepared by Olaf P. Jenkins. Commercial minerals of California (chart).

131. Consolidated index of publications, Division of Mines and State Mining Bureau, 1880-1943, by Walter W. Bradley, 1945. 872 pp., i-xxi. Price $8.75.

*132. California mineral production and directory of mineral producers for 1944, by Henry H. Symons. 1945. 224 pp., 6 illus.

133. Geology of the San Juan Bautista quadrangle, California. 1946. 112 pp., 12 pls., 1 index map., 10 figs. Paper-bound, price $1.50; cloth-bound, price $2.25.

Contains: Map of California, index to quadrangles published by Division of Mines, op. p. 7; Preface, by Olaf P. Jenkins, pp. 7-8; Geology of the San Juan Bautista quadrangle, California, by John Eliot Allen, pp. 9-75, pls. 1-8, figs. 1-10; Operations of the Granite Rock Company quarry and plant at Logan, San Benito County, by Royal E. Fowle, pp. 77-81, pls. 9-12.

The following are included with bulletin, or may be purchased alone: Geologic map of the San Juan Bautista quadrangle, California, scale 1:62,500, pl. 1; Economic mineral map of the San Juan Bautista quadrangle showing position of structure sections, scale 1:62,500, pl. 2; Structure sections across San Juan Bautista quadrangle, scale 1" = 1 mi., pl. 3. Set of 3 maps, price 50¢.

134. Geological investigations of chromite in California, prepared under the direction of Olaf P. Jenkins.

Issued in separate parts and chapters, as indicated below.

(a) Part I, Klamath Mountains.

* Chapter 1, Chromite deposits of Del Norte County, California, by Francis G. Wells, Fred W. Cater, Jr. and Garn A. Rynearson, pp. 1-76, pls. 1-11, 9 figs., 1946.

The following is included with the report or may be purchased alone: Topographic map of Del Norte County, California, showing distribution of peridotite and location of chromite deposits, scale 1" = 2 mi. Price 40¢.

Chapter 2, Chromite deposits of Siskiyou County, California, by Francis G. Wells and Fred W. Cater, Jr., pp. 77-127, pls. 13-18, 4 figs., 1950. Price $1.00.

The following is included with the report or may be purchased alone: Topographic map of Siskiyou County west of meridian 122° 10′, showing distribution of known peridotite and location of chromite occurrences, scale 1" = 2 mi. Price 75¢.

(b) Part II, Coast Ranges.

Chapter 1, Chromite deposits of the northern Coast Ranges of California, by D. H. Dow and T. P. Thayer, pp. 1-38, 2 figs., 1946. Price 25¢.

(c) Part III, Sierra Nevada.

Chapter 1, Chromite deposits of Tuolumne and Mariposa Counties, California, by Fred W. Cater, Jr., pp. 1-32, pls. 1-4, 2 figs., 1948. Price 35¢.

Chapter 2, Chromite deposits of Calaveras and Amador Counties, California, by Fred W. Cater, Jr., pp. 33-60, pl. 5, fig. 1, 1948. Price 35¢.

* Chapter 3, Chromite deposits of Tulare and eastern Fresno Counties, California, by Garn A. Rynearson, pp. 61-104, pls. 6-7, 7 figs., 1948.

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135. Placer mining for gold in California, by Charles Volney Averill. *1st ed., 1946. 2d ed., 1950. 377 pp., 4 pls., 106 figs. Price $2.50.

Contains: *Placer mining methods, pp. 11-146, pl. 1, figs. 1-45, which includes* Small-scale methods, pp. 13-33, figs. 1-9; Dragline dredging, pp. 34-48, pl. 1, figs. 10-18; Dryland dredges, pp. 49-50, fig. 19; Bucket-line dredging, by Charles M. Romanowitz and Herbert A. Sawin, pp. 51-60, figs. 20-22; Becker-Hopkins single-bucket dredge, by H. A. Sawin, pp. 61-62, figs. 23-24; Jigging applied to gold dredging, by P. Malozemoff, pp. 63-72, fig. 25; Notes on jigs for gold dredges, by F. W. Collins, pp. 73-76, figs. 26-29; Treatment of black sand, pp. 77-80, fig. 30; Drift mining, general description, pp. 81-88, fig. 31; A synoptic presumption regarding California's drift mines, by L. L. Huelsdonk, pp. 89-91; Hydraulic mining, pp. 93-143, figs. 32-45; Debris dams, pp. 144-146. *Geology of placer deposits, pp. 146-216, figs. 46-80, which includes* New technique applicable to the study of placers, by Olaf P. Jenkins, pp. 149-216, figs. 46-80. *Prospecting and sampling placer deposits, pp. 217-227, which includes* Sampling, pp. 219-226; Geophysical prospecting, p. 227. *Placer mines by counties, pp. 229-322, figs. 81-106, which includes* Amador, Butte, Calaveras, El Dorado, Fresno, Humboldt, Imperial, Kern, Los Angeles, Madera, Mariposa, Merced, Nevada, Placer, Plumas, Sacramento, San Bernardino, San Joaquin, Shasta, Sierra, Siskiyou, Stanislaus, Trinity, Tuolumne, Yuba Counties, pp. 231-315, figs. 81-104; Deep gravels dredged successfully, by Herbert A. Sawin, pp. 317-322, figs. 105-106. *Appendix—laws affecting placer mining, pp. 323-336, which includes* The Caminetti Law, pp. 325-330; Amendments to the Caminetti Act, pp. 331-333; Definition of hydraulic mining, p. 333; Definition of hydraulic mining from California Civil Code, p. 333; Trinity and Klamath River fish and game district, p. 334; Protection of domestic water supplies, pp. 335-336; Placer mining districts, p. 336; Map showing Tertiary gravel channels, Nevada County, California, scale 2″ = 3 mi. (approx.), pl. 2, in pocket.

The following are included with bulletin, or may be purchased separately: Geologic map of northern Sierra Nevada showing Tertiary river channels and Mother Lode belt, prepared by Olaf P. Jenkins, scale 1″ = 8 mi., pl. 3, (*Report accompanying geologic map of northern Sierra Nevada*, by Olaf P. Jenkins, printed on back), price 25¢. Map of northern California showing placer mining areas, scale 1″ = 18 mi., pl. 4, price 25¢.

136. Minerals of California, by Joseph Murdoch and Robert W. Webb. 1948. 402 pp., 4 pls., 1 fig. Price $3.00.

*137. California mineral production and directory of mineral producers for 1945, by Henry H. Symons. 1946. 221 pp.

*138. Manner of locating and holding mineral claims in California, by A. H. Ricketts (with revisions by C. A. Logan). 1946. 35 pp.

139. California mineral production for 1946, by C. V. Averill, C. R. King, Henry H. Symons, and F. F. Davis. 1948. 176 pp., 4 pls. Price 75¢.

Contains: Summary of the mineral industry in California during the year 1946, pp. 9-10; Fuels, pp. 11-27; Metals, pp. 29-56; Industrial nonmetallic materials, pp. 57-102; Salines, pp. 103-112. Appendix, pp. 113-172: List of counties in California, showing amount and value of the mineral substances produced in each during 1946, pp. 115-127; Directory of producers of metallic and nonmetallic minerals in California in 1946, pp. 129-167; List of smelters reporting purchase of California metals produced in 1946, p. 168; List of custom mills and commercial grinding plants in California, p. 169; List of quicksilver buyers and mineral brokers, p. 170; List of commercial assay and testing laboratories, p. 171.

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140. Geology of the Tesla quadrangle, California, by Arthur S. Huey. 1948. 75 pp., 11 pls., 3 figs. Paper-bound, price $1.50.

The following are included with bulletin, or may be purchased separately: Colored geologic map on topographic base of Tesla quadrangle, scale 1:62,500; Topographic map of Tesla quadrangle with red overprint showing mineral deposits, structure-section lines, and water-supply tunnel, scale 1:62,500; Structure sections across Tesla quadrangle. Set of maps and structure sections also sold separately, price 75¢.

141. Geologic guidebook along Highway 49—Sierran gold belt—the Mother Lode country. *1st ed., 1948. 2d ed., 1949. 164 pp., 2 pls., 221 figs., 10 maps. Price $1.00.

Contains: Preface, by Olaf P. Jenkins, p. 7; Publications consulted, p. 8; Sierran roads of today and yesterday, by Dorothy G. Jenkins, pp. 9-12, 2 figs.; The discovery of gold in California, by Donald C. Cutter, pp. 13-17, 2 figs.; History of placer mining for gold in California, by Charles V. Averill, p. 19, 6 figs.; Sierra Nevada province, by Olaf P. Jenkins, p. 21, 1 fig.; Geologic history of the Sierran gold belt, by Olaf P. Jenkins, pp. 23-30, 11 figs.; History of mining and milling methods in California, by C. A. Logan, pp. 31-34, 1 fig.; Geologic maps and notes along Highway 49, by Oliver E. Bowen Jr. and Richard A. Crippen Jr., pp. 35-86, 42 figs., 10 maps; The formation of quartz veins, by John A. Burgess, pp. 87-88, 3 figs.; Mining on Carson Hill, by John A. Burgess, pp. 89-90; Survey of building structures of the Sierran gold belt, 1848-70, by Robert F. Heizer and Franklin Fenenga, pp. 91-164, 168 figs.

142. The counties of California—mineral resources and mineral production during 1947, prepared under the direction of Olaf P. Jenkins, contributing authors Charles V. Averill, Oliver E. Bowen Jr., Fenelon F. Davis, Clarence A. Logan, Lewis A. Norman Jr., John C. O'Brien, Reid J. Sampson, Richard M. Stewart, Henry H. Symons, William E. Ver Planck. 1949. 197 pp., 12 pls., 1 fig. Price $1.25.

143. Geology of the Hollister quadrangle, California, by N. L. Taliaferro (in press).

Contains: Colored geologic map on topographic base of Hollister quadrangle, scale 1:62,500; Topographic map of Hollister quadrangle with red overprint showing mineral deposits, and structure-section lines, scale 1:62,500. Set of maps, sold separately, price 75¢.

144. Copper in California. 1948. 429 pp. 9 pls. in text, 52 pls. in separate pocket, map, 20 figs. Price $6.00.

Contains: **Part 1, Detailed reports on the Foothill copper belt, pp. 9-157, 16 figs., 61 pls.:** Foothill copper-zinc belt of the Sierra Nevada, California, by George R. Heyl, pp. 11-29, pl. 1; Zinc-copper deposits of the Big Bend mine, Butte County, California, by John H. Eric, pp. 31-42, 1 fig., pls. 2-4; Geology of the Lilyama and Pioneer mines, El Dorado County, California, by Manning W. Cox, Donald C. Wyant, and George R. Heyl, pp. 43-47, pls. 5-6; Newton copper mine, Amador County, California, by George R. Heyl and John H. Eric, pp. 49-60, 2 figs., pls. 7-13; Penn zinc-copper mine, Calaveras County, California, by George R. Heyl, Manning W. Cox, and John H. Eric, pp. 61-84, 4 figs., pls. 14-32; The Grayhouse area, Amador County, California, by George R. Heyl, pp. 85-91, 2 figs., pl. 33; Ore deposits of Copperopolis, Calaveras County, California, by George R. Heyl, pp. 93-110, pls. 34-40; The zinc-copper mines of the Quail Hill area, Calaveras County, California, by George R. Heyl, pp. 111-126, 3 figs., pls. 41-46; La Victoria copper mine, Mariposa County, California, by Manning W. Cox and Donald G. Wyant, pp. 127-132, 1 fig.,

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pls. 47-49; Zinc deposits of the American Eagle—Blue Moon area, Mariposa County, California, by John H. Eric and Manning W. Cox, pp. 133-150, 1 fig., pls. 50-58; The Jesse Belle copper mine, Madera County, California, by Manning W. Cox and Donald G. Wyant, pp. 151-157, 2 figs., pls. 59-61. **Part 2, Economics and treatment of ores, pp. 159-196, 4 figs.:** The marketing and metallurgy of complex ores in California, by Hadley R. Bramel, pp. 161-196, 4 figs. **Part 3, Tabulation of copper properties to accompany Economic Mineral Map of California No. 6 (Copper), pp. 197-387, 2 figs.:** Tabulation of copper deposits of California, by John H. Eric, pp. 199-357, 2 figs.; Bibliography, by Hadley R. Bramel, John H. Eric, and Elisabeth L. Egenhoff, pp. 359-387. Index, pp. 389-429.

The following is included with the bulletin, or may be purchased separately: Outline geologic map of California showing locations of copper properties (Economic mineral map of California No. 6—Copper), scale 1:1,000,000, prepared under direction of Olaf P. Jenkins; sold separately, price $1.00.

145. Geology of the Copperopolis quadrangle, California,by N. L. Taliaferro (in press).

Contains: Colored geologic map on topographic base of Copperopolis quadrangle, scale 1:62,500; Topographic map of Copperopolis quadrangle with red overprint showing mineral deposits, and structure-section lines, scale 1:62,500. Set of maps, sold separately, price 75¢.

146. Geology of the Lake Elsinore quadrangle, California, by René Engel (in press).

Contains: Colored geologic map on topographic base of Lake Elsinore quadrangle, scale 1:62,500; Topographic map of Lake Elsinore quadrangle with red overprint showing mineral deposits, and structure-section lines, scale 1:62,500. Set of maps, sold separately, price 75¢.

147. Geology of the Quien Sabe quadrangle, California. 1949. 60 pp., 11 pls., 6 figs. Price $1.75.

Contains: Geology of the Quien Sabe quadrangle, California, by Carlton James Leith, pp. 7-35, pls. 1-7, 2 figs.; Quicksilver and antimony deposits of the Stayton district, California, by Edgar H. Bailey and W. Bradley Myers, pp. 37-56, pls. 8-11, 4 figs.; Index, pp. 57-60.

The following are included with the bulletin, or may be purchased separately: Colored geologic map on topographic base of Quien Sabe quadrangle, scale 1:62,500; Topographic map of Quien Sabe quadrangle with red overprint showing mineral deposits, and structure-section lines, scale 1:62,500; Geologic structure sections across Quien Sabe quadrangle. Set of maps and structure sections, sold separately, price 75¢.

148. Geology of the Blue Lake quadrangle, California. 1950. 36 pp., 13 pls., 2 figs. Price $1.50. In press.

Contains: Geology of the Blue Lake quadrangle, California, by George A. Manning and Burdette A. Ogle, pp. 7-31, 13 pls., 2 figs.; Index, pp. 33-36.

The following are included with the bulletin, or may be purchased separately: Colored geologic map on topographic base of Blue Lake quadrangle, scale 1:62,500; Topographic map of Blue Lake quadrangle with red overprint showing mineral deposits, and structure-section lines, scale 1:62,500; Geologic structure sections across Blue Lake quadrangle. Set of maps and structure sections, sold separately, price 75¢.

149. Geology and mineral deposits of an area north of San Francisco Bay, California—Vacaville, Antioch, Mount Vaca, Carquinez, Mare Island, Sonoma, Santa Rosa, Petaluma, and Point Reyes quadrangles. 1949. 135 pp., 24 pls., 4 figs. Price $4.00. In press.

Contains: Geology and mineral deposits of an area north of San Francisco Bay, California—Vacaville, Antioch, Mount Vaca, Carquinez,

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Mare Island, Sonoma, Santa Rosa, Petaluma, and Point Reyes quadrangles, by Charles E. Weaver, pp. 7-122, 24 pls., 4 figs.; Index, pp. 123-135. Maps (pls. 1-24) are in separate map box.

The following are included with the bulletin. Those not marked with asterisk (*) may be purchased separately: *Colored geologic map on topographic base of Santa Rosa quadrangle, scale 1:62,500; Topographic map of Santa Rosa quadrangle with red overprint showing mineral deposits, and structure-section lines, scale 1:62,500. *Colored geologic map on topographic base of Sonoma and Mt. Vaca quadrangles, scale 1:62,500; Topographic man of Sonoma and Mt. Vaca quadrangles with red overprint showing mineral deposits, and structure-section lines, scale 1:62,500. *Colored geologic map on topographic base of Vacaville quadrangle, scale 1:62,500; Topographic map of Vacaville quadrangle with red overprint showing mineral deposits, and structure-section lines, scale 1:62,500.*Colored geologic map on topographic base of Pt. Reyes quadrangle, scale 1:62,500; Topographic map of Pt. Reyes quadrangle with red overprint showing mineral deposits, and structure-section lines, scale 1:62,500. *Colored geologic map on topographic base of Petaluma quadrangle, scale 1:62,500; Topographic map of Petaluma quadrangle with red overprint showing mineral deposits, and structure-section lines, scale 1:62,500. Colored geologic map on topographic base of Mare Island quadrangle, scale 1:62,500; Topographic map of Mare Island quadrangle with red overprint showing mineral deposits, and structure-section lines, scale 1:62,500; set of two maps, price 50¢. Colored geologic map on topographic base of Carquinez quadrangle, scale 1:62,500; Topographic map of Carquinez quadrangle with red overprint showing mineral deposits, and structure-section lines, scale 1:62,500; set of two maps, price 50¢. Colored geologic map on topographic base of Antioch quadrangle, scale 1:62,500; Topographic map of Antioch quadrangle with red overprint showing mineral deposits, and structure-section lines, scale 1:62,500; set of two maps, price 50¢. Geologic sections across an area north of San Francisco Bay, price 25¢.

150. Geology of southwestern Santa Barbara County, California—Point Arguello, Lompoc, Point Conception, Los Olivos, and Gaviota quadrangles. 1950. 95 pp., 17 pls., 6 figs., frontis. Price $5.00.

Contains: Geology of southwestern Santa Barbara County, California (Point Arguello, Lompoc, Point Conception, Los Olivos, and Gaviota quadrangles), by T. W. Dibblee Jr., pp. 7-84, 17 pls., 6 figs.; Index, pp. 85-95.

The following are included with the bulletin, or may be purchased separately: Colored geologic map on topographic base of Point Arguello, Lompoc, and Point Conception quadrangles, scale 1:62,500; Topographic map of Point Arguello, Lompoc, and Point Conception quadrangles with red overprint showing mineral deposits, and structure-section lines, scale 1:62,500; set of two maps, price $1.50. Colored geologic map on topographic base of Los Olivos and Gaviota quadrangles, scale 1:62,500; Topographic map of Los Olivos and Gaviota quadrangles with red overprint showing mineral deposits, and structure-section lines, scale 1:62,500; set of two maps, price $1.50. Geologic structure sections across southwestern Santa Barbara County, price 50¢.

151. Geology of the Macdoel quadrangle, California. 1949. 78 pp., 4 pls., 13 figs. Price $1.75.

Contains: Geology of the Macdoel quadrangle, California, by Howel Williams, pp. 7-60, pls. 1-4, 8 figs.; Circular soil structures in northeastern California, by Peter H. Masson, pp. 61-71, 5 figs.; Index, pp. 73-78.

The following are included with the bulletin, or may be purchased separately: Colored geologic map on topographic base of Macdoel quadrangle, scale 1:125,000; Topographic map of Macdoel quadrangle with red overprint showing mineral deposits and structure-section lines, scale 1:125,000; Geologic sections across the Macdoel quadrangle, scale 1″ = 2 mi.; set of maps and sections, price 75¢.

152. Geologic description of the manganese deposits of California—supplement to Bulletin 125, by Parker D. Trask, Glen Alvey, Edgar Bowles, Doak C. Cox, S. C. Creasey, Max D. Crittenden Jr., Theo Crook, E. F. Davis, J. B. Hadley, F. S. Hudson, Charles B. Hunt, S. G. Lasky, J. M. Nelson, H. P. Norbeck, R. R.

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Morse, W. G. Pierce, Spangler Ricker, A. F. Shride, Frank S. Simons, N. L. Taliaferro, Fred D. Trauger, Charles R. Warren, Ivan F. Wilson, Alfred O. Woodford. 1950. 378 pp., 20 pls., 12 figs. Price $2.75.

153. Geology and mineral resources of the Neenach quadrangle, California, by John H. Wiese. 1950. 53 pp., 12 pls., 1 fig. Price $1.75.

Contains: Colored geologic map on topographic base of Neenach quadrangle, scale 1:62,500; Topographic map of Neenach quadrangle with red overprint showing mineral deposits and structure-section lines; Geologic structure sections across Neenach quadrangle. Set of maps and structure sections, price 75¢.

154. In press.

155. In press.

156. Mineral commodities of California—geologic occurrence, economic development, and utilization of the state's mineral resources, by the staff of the Division of Mines, under the direction of Olaf P. Jenkins. 1950. 443 pp., 17 pls., 34 figs., frontis. Price $2.00.

Contains: Preface, by Olaf P. Jenkins, pp. 11-13; Natural environment of mineral resources of California, by Olaf P. Jenkins, pp. 15-21, pl. 1.

Part 1, Summary of mineral wealth in California for 1948, pp. 23-58: Mineral production in California during 1948 compared with 1947, by Henry H. Symons, Fenelon F. Davis, and Charles V. Averill, pp. 25-40; Contributions of the counties to the mineral production of California during 1948, by Henry H. Symons, Fenelon F. Davis, and Charles V. Averill, pp. 41-58.

Part 2, Mineral fuels, pp. 59-108, 4 figs.: Coal, by Lewis T. Braun, pp. 61-64; Coke, by James W. Vernon, pp. 64-65; Natural gas, by Gordon B. Oakeshott, pp. 66-79, 1 fig.; Natural gasoline and liquefied petroleum gases, by Gordon B. Oakeshott, pp. 80-83; Peat, by Lewis T. Braun, pp. 83-84; Petroleum, by Gordon B. Oakeshott, pp. 85-108, 3 figs.

Part 3, Nonmetallic industrial materials, pp. 109-282, pls. 2-17, 20 figs.: Abrasives, by Lewis T. Braun, pp. 111-116; Andalusite, kyanite, and sillimanite, by Lauren A. Wright, pp. 116-118; Arsenic, by L. A. Norman Jr., pp. 118-120; Asbestos, by Fenelon F. Davis, pp. 121-124; Asphalt and bituminous rock, by Gordon B. Oakeshott, pp. 124-130; Barite, by Lewis T. Braun, pp. 130-132; Beryllium, by Lauren A. Wright, pp. 132-133; Black sands, by Gordon B. Oakeshott, pp. 133-136; Calcite (optical), by Lauren A. Wright, pp. 136-138; Cement, by Oliver E. Bowen Jr., pp. 138-142, 1 fig.; Clays, by Mort D. Turner, pp. 142-150, 1 fig., Diatomite, by Gordon B. Oakeshott, pp. 150-155, 1 fig.; Dolomite, by Clarence A. Logan and Lauren A. Wright, pp. 155-158; Feldspar, by Lauren A. Wright, pp. 158-161; Fluorspar, by Charles W. Chesterman, pp. 161-164; Gem stones, by Lauren A. Wright, pp. 164-169; Graphite, by Gordon B. Oakeshott, pp. 169-171; Lime and limestone, by Oliver E. Bowen Jr., pp. 171-176, 1 fig.; Magnesite, magnesium, and magnesium compounds, by James W. Vernon, pp. 177-184, 1 fig.; Mica, by Lauren A. Wright, pp. 184-186; Nitrogen compounds, by William E. Ver Planck Jr., pp. 186-187; Pebbles for grinding, by L. A. Norman Jr., pp. 187-189; Phosphates, by Lewis T. Braun, pp. 189-192; Pumice, pumicite, and perlite, by Charles W. Chesterman, pp. 192-203, 1 fig.; Pyrites, by Charles W. Chesterman, pp. 203-206, 1 fig.; Quartz crystal, by Lauren A. Wright, pp. 206-208; Salines, by William E. Ver Planck Jr., pp. 208-251, 9 figs.;

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Sand and gravel, by Mort D. Turner, pp. 251-258, 1 fig.; Slate, by Mort D. Turner, pp. 258-260; Stone, by Mort D. Turner, pp. 260-270, 1 fig.; Strontium minerals, by William E. Ver Planck Jr., pp. 270-273, 1 fig.; Sulfur, by James W. Vernon, pp. 273-275; Sulfuric acid, by James W. Vernon, pp. 275-276; Talc, soapstone, and pyrophyllite, by Lauren A. Wright, pp. 276-282, 1 fig.

Part 4, Metals, pp. 283-370, 10 figs.: Aluminum, by Mort D. Turner, pp. 285-288; Antimony, by L. A. Norman Jr., pp. 288-291; Bismuth, by Charles W. Chesterman, pp. 291-293; Cadmium, by James W. Vernon, pp. 293-294; Chromite, by Richard A. Crippen Jr., pp. 294-298, 1 fig.; Cobalt, by Lewis T. Braun, pp. 299-300; Copper, by John C. O'Brien and James W. Crosby III, pp. 300-307, 1 fig.; Ferro-alloys, by James W. Vernon, pp. 308-309; Gold, by Clarence A. Logan, pp. 309-315, 1 fig.; Iron, by James W. Vernon, pp. 315-319, 1 fig.; Lead, by Richard M. Stewart, pp. 319-324, 1 fig.; Manganese, by Richard A. Crippen Jr., pp. 324-329, 1 fig.; Mercury, by Richard A. Crippen Jr., pp. 330-337, 1 fig.; Molybdenum, by Richard M. Stewart, pp. 337-340; Platinum and allied metals, by Clarence A. Logan, pp. 340-343; Silver, by Richard M. Stewart, pp. 343-349, 1 fig.; Tin, by L. A. Norman Jr., pp. 349-352; Titanium, by Gordon B. Oakeshott, pp. 352-355; Tungsten, by Richard M. Stewart, pp. 355-361, 1 fig.; Uranium, thorium, and rare-earth elements, by Charles W. Chesterman, pp. 361-363; Zinc, by John C. O'Brien, pp. 364-368, 1 fig.; Zirconium, by Samuel R. Hoffman, pp. 368-370.

Part 5, Directory of mineral producers, dealers, and commercial laboratories, pp. 371-421: Directory of producers of metallic and nonmetallic minerals in California during 1948, pp. 373-417; List of smelters and mineral dealers reporting purchase of California metals produced in 1948, p. 418; List of mineral dealers, custom mills, and commercial grinding plants in California, pp. 419-420; List of commercial assay and testing laboratories, pp. 420-421.

Index, pp. 423-443.

The following is included with the bulletin, or may be purchased separately: Map of California, showing distribution of mineral deposits, scale 1″ = 40 mi., and Salient features of the geomorphic provinces, by Olaf P. Jenkins. Price 50¢.

*** All publications marked with an asterisk (*) are out of print and cannot be obtained from the Division of Mines. Please do not send any money for publications so marked.**

SPECIAL REPORTS (SR)

1A. Sierra Blanca limestone in Santa Barbara County, California, by George W. Walker. 1950. 5 pp., 1 pl. Price 25¢.

1B. The Calera limestone in San Mateo and Santa Clara Counties, California, by George W. Walker. 1950. 8 pp., 1 pl., 6 figs. Price 25¢.

2. Geology of part of the Delta-Mendota Canal near Tracy, California, by Parry Reiche. 1950. 12 pp., 5 figs. Price 25¢.

3. Commercial "Black Granite" of San Diego County, California, by Richard A. Hoppin and L. A. Norman Jr. 1950. 19 pp., 18 figs. Price 25¢.

4. Geology of the San Dieguito pyrophyllite area, San Diego County, California, by Richard H. Jahns and John F. Lance. 1950. 32 pp., 2 pls., 21 figs. Price 50¢.

5. Geology of the Jurupa Mountains, San Bernardino and Riverside Counties, California. 1951. 14 pp., 1 pl., 14 figs. Price 25¢.

6. Geology of Bitterwater Creek Area, Kern County, California, by Henry H. Heikkila and George M. MacLeod. 1951. 21 pp., 2 pls., 15 figs. Price 35¢.

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* All publications marked with an asterisk (*) are out of print and cannot be obtained from the Division of Mines. Please do not send any money for publications so marked.

LIST OF DEPOSITORY LIBRARIES SHOWING HOLDINGS OF DIVISION OF MINES PUBLICATIONS

Third Edition, November 1950

INTRODUCTION[1]

For many years the Division of Mines has been sending copies of its publications to libraries. This is in keeping with the California statute of 1939, which states that ''He (the State Mineralogist) may also furnish the publications of the Division to public libraries without cost and may exchange publications with geological surveys, scientific societies, and other like bodies.''

The libraries in the following list are those which receive Division of Mines publications. This list has been arranged as follows: (1) California libraries, alphabetically by town and name of library; (2) Libraries in states other than California, alphabetically by state, city and name of library; (3) Libraries in foreign countries, alphabetically by country and city.

The abbreviations used are: M, Maps; SP, Special Publications; PR, Preliminary Reports; RM, Register of Mines; R, Reports of the State Mineralogist; J, California Journal of Mines and Geology; B, Bulletins; and SR, Special Reports.

A plus sign following the last number in a series (B 10, 112, 113, 115+) indicates that the library has received all subsequent issues in the series.

Division publications not in a certain library may be borrowed on inter-library loan from the California State Library in Sacramento.

California

[Libraries marked with an asterisk (*) receive Division publications but the extent of their holdings is unknown; those marked with a dagger (†) receive only the California Journal of Mines and Geology.]

Alameda, Alameda County
Alameda Free Library
M 16, 18, 19; RM 19-20; R 1-14, 17, 18d,g,h,i,j,l, 19b,c,d, 20a,b,d, 21a, 22c, 23a,b,d, 24a,d, 25c,d, 26a,d, 27a,b,d, 28a,c, 29b, 30, 31a,b,d, 32-33, 34b,c,d, 35-42; J 43+; B 2-6, 9-11, 23, 30, 38, 45-46, 50, 57, 74, 76-79, 83, 86, 88-91, 94, 98-99, 101, 104, 106-107, 109-119, 121-122, 125+

Alhambra, Los Angeles County
Alhambra Public Library, 410 West Main St.
R 18e,f, 19d, 20a,b,d, 21b, 22a,c,d, 23a,c,d, 25a,c, 26a,b,d, 27a,d, 34b,c,d, 35, 36a,b,d, 37b,c,d, 38a,c, 39a,b,d, 40a,b,c; J 43+; B 96, 103, 105, 107, 113

Alturas, Modoc County
Modoc County Free Library*

Anaheim, Orange County
Anaheim Public Library, 241 South Los Angeles St.
J 43+; B 139+

Arcata, Humboldt County
Humboldt State College Library
RM 7; R 29a, 32a,b, 34c,d, 35b,c,d, 36-42; J 43+; B 137

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[1] Prepared by Roy Nielsen, Librarian, California State Division of Mines, November 2, 1950.

Auburn, Placer County
Auburn City Library, 175 Almond St.
Placer County Free Library
J 43+ ; B 139+

Azusa, Los Angeles County
Citrus Union High School and Junior College Library
J 46c+ ; B 148, 150, 152+

Bakersfield, Kern County
Kern County Free Library
R 2, 6-13, 15-42 ; J 43+ ; B 3-7, 9-11, 16, 23, 27, 32, 37, 50, 57, 63, 65-66, 68-76, 78-79, 83-84, 86-114, 116-137+

Balboa, Orange County
Newport Beach Public Library, 106 Island Ave.

Beaumont, Riverside County
Beaumont District Library
R 23a,d, 24a,b,c, 25c,d, 26a,b,c, 27-28, 31d, 34-42 ; J 43+ ; B 106, 131, 137, 139+

Berkeley, Alameda County
Berkeley Public Library, Shattuck and Kittredge
M 18 ; RM 1-4 ; R 2-12, 14-23, 24b,c,d, 25-42, J 43+ ; B 6, 23, 32, 37-38, 46-47, 49-56, 58-59, 62-74, 76-79, 83-122, 124-127, 131+
University of California Library, Documents Dept.
Complete.

Blythe, Riverside County
Blythe Public Library

Burbank, Los Angeles County
Burbank Public Library
J 46+ ; B 148, 150, 152+

Carmel, Monterey County
Carmel Public Library, Box 800

Chico, Butte County
Chico Public Library
J 43+ ; B 139+
Chico State College Library
R 16a, 23d, 24b, 25c,d, 38-42 ; J 43+ ; B 38, 104, 108, 113, 115, 133, 137

Chula Vista, San Diego County
Chula Vista Public Library
R 33, 34b,d, 35c,d, 36-42 ; J 43+ ; B 1-3, 5, 7, 9-10, 17-18, 20, 26-27, 30-32, 36, 38-39, 139+

Claremont, Los Angeles County
Claremont College Library
R 1-2, 5-42 ; J 43+ ; B 4, 6, 19, 23, 37-38, 46, 50, 54-74, 76-88, 91+
Pomona College Library
R 3-4, 6-13, 17, 18-42 ; J 43+ ; B 1-6, 9-11, 16, 18-19, 23-24, 27, 30-37, 53, 63, 68-69, 72, 74-78, 83, 89, 91, 95, 104, 115, 118, 121, 131, 135-137

Coalinga, Fresno County
Coalinga District Library
M 18 ; R 6, 18h, 20b,d, 22c, 25c, 27b, 34a, 35c, 37-40, 41b,c,d, 42a,c,d ; J 43+ ; B 6, 27, 32, 37, 63, 69, 82, 84, 104, 115, 118, 120, 122-124, 130-131, 137+

Colton, San Bernardino County
Colton Public Library
J 45+ ; B 147+

Colusa, Colusa County
Colusa County Free Library, Hall of Records Bldg.*

Compton, Los Angeles County
Compton College Library, 601 Acacia St.
J 45d+ ; B 150, 152+

Crescent City, Del Norte County
Crescent City Public Library
J 43+ ; B 139+

Davis, Yolo County
University of California, College of Agriculture*

Death Valley, Inyo County
Death Valley National Monument Library

Downieville, Sierra County
Downieville Branch Plumas County Free Library
J 44d+ ; B 136+

El Centro, Imperial County
El Centro Public Library
Imperial County Free Library

Escondido, San Diego County
Escondido Public Library, 255 South Kalmia St.
R 14, 21,c,d, 22, 23a,b,c, 25, 26b,c,d, 27a,b, 28a,c, 29, 30c, 31b,c, 33b; J 43+ ; B 72, 79, 92, 139+

Eureka, Humboldt County
Eureka Free Library, 7th and F Sts.
R 16a, 18d,f,h, 19a,b, 20a,c, 21, 23a,b, 24-25, 26a,c,d, 27b,d, 28a, 31b,d, 32, 33b,c, 34a,d, 35a,b,c, 36a,c, 37d, 38-42; J 43+ ; B 45, 66, 70-74, 77, 79, 83, 85-86, 88, 90-92, 98-99, 104, 106, 108, 111-112, 114-119, 122-123, 125-126, 128+

Fairfield, Solano County
Solano County Free Library

Fresno, Fresno County
Fresno County Free Library, 1330 Broadway
M 16; RM 11; R 5-11, 14-42; J 43+ ; B 2, 6, 19, 23-24, 27, 30, 37-38, 47, 50-52, 54-59, 61-71, 73-79, 83-97, 99+

Fresno State College Library
R 11, 18c,d,g,h,i,j,l, 19, 20a,b,d, 21a,b,c, 22-24, 25b,c,d, 26-29, 30a,b, 31a,c,d, 32-33, 34b,c,d, 35-37, 39a,b,d, 40, 41a,c,d, 42; J 43+ ; B 23, 50, 70-71, 74, 79, 83, 86-88, 90-91, 93-103, 107, 109-112, 114, 116-118, 121-123, 125-126, 128+

Fullerton, Orange County
Fullerton Junior College Library, East Chapman Ave.
J 46b+ ; B 153+
Fullerton Public Library, 301 North Pomona Ave.
R 18-28, 29b, 30a,c, 31a,b,d, 32-42; J 43+ ; B 27, 36-37, 50, 57, 63, 72, 75, 76, 79, 83-88, 90-94, 97-99, 101-102, 104-119, 121-137+

Glendale, Los Angeles County
Glendale Public Library, 319 E. Harvard St.
R 22-32, 35, 37-40, 42; J 43+ ; B 50, 64-65, 74, 76-77, 79, 83, 86, 88, 90, 93, 97, 99, 101-103, 106-112, 135+

Glendora, Los Angeles County
Glendora Public Library
J 46+ ; B 153+

Grass Valley, Nevada County
Grass Valley Free Public Library
R 8, 13-14, 16a,c, 18d,g,h,j,l, 19, 25c, 27a,b,d, 28c, 29, 30a,c, 31a,b,d, 32b,c,d, 33a, 35a,d, 37b,c,d, 38-42; J 43+ ; B 23, 50, 71, 83, 86, 88, 90, 92-94, 98, 102-105, 107-111, 117-119, 121-126, 128+

Hanford, Kings County
Hanford Public Library †
Kings County Free Library *

Hemet, Riverside County
Hemet Public Library, 510 E. Florida Ave.
R 22a, 28a,c, 30c, 31a, 32-33, 34a,b,c, 35-41, 42a,b; J 43+ ; B 85, 137+

Hollister, San Benito County
San Benito County Free Library
M 18; R 26a, 29b, 30b,c, 31a,c,d, 32, 33a,b,d, 34-35, 36a,b,c, 37-42; J 43+ ; B 46, 72, 74, 76-83, 86, 89, 91, 99, 104, 106, 113-116, 120, 131, 135

Independence, Inyo County
Inyo County Free Library
M 18; R 16b,c, 28b, 29a, 30, 31d, 32b,c,d, 34d, 35-42; J 43+ ; B 6, 50, 57, 63-65, 68-71, 73-79, 83, 85-86, 88-91, 94, 96-97, 99-108, 110-111, 113-115, 118-119, 121-123, 125-126, 128+

Jackson, Amador County
Amador County Library
RM 12; R 10, 12-14, 16, 29-30, 32-42; J 43+; B 76, 79, 88, 93-94, 96-97, 100-103, 105, 107-111, 113-114, 116-117, 119, 121-122, 124, 126, 131+

Kentfield, Marin County
College of Marin Library

Lakeport, Lake County
Lakeport Carnegie Library
R 8, 10, 24b, 25d, 26a, 27c,d, 28a,c, 29a, 30c, 31d, 32b,d, 34c,d, 35b, 36a,d, 37d, 38a,c, 39-42; J 43+; B 105, 131, 135-137

Lodi, San Joaquin County
Lodi Public Library, 305 West Pine St.
M 18; R 34-42; J 43+; B 135-137+

Long Beach, Los Angeles County
Long Beach Public Library, Document Division
M 16, 18, 19; R 1-42; J 43+; B 3, 6, 11, 16, 19, 23, 27, 30, 32, 36, 38, 46, 50, 57, 63-65, 67-72, 74-79, 83, 85-94, 96+

Los Angeles, Los Angeles County
California State Division of Mines, State Building, 217 West First St.
M 16, 18, 19; RM 1-21; R 1-42; J 43+; B 1-13, 15-16, 18-19, 21-32, 34+
Los Angeles County Library, 322 South Broadway
RM 5-8, 10, 12, 14-19, 21; R 6-13, 17+; J*; B 1, 6, 9-10, 23, 27, 30, 32, 37-38, 63-115, 118, 120-121, 123-124, 126-127, 130+
Los Angeles County Museum Library, Exposition Park
R 6-8, 13, 19b,c, 28-42; J 43+; B 3, 6, 20, 32, 37, 50, 56, 62-63, 65-66, 68-71, 90-91, 104, 107-117, 119, 121-123, 125-126, 130-131, 135-137+
Los Angeles Public Library
Arroyo Seco Branch, 6145 North Figueroa St.
J 43+; B 139+
Gardena Branch of Los Angeles Public Library
J 45+; B 144+
Junipero Serra Branch, 4255 Olive St.
B 91, 113, 138+
Main Library*
Serials Division, 630 West 5th St.
M 18, 19, RM 1-21; R 2, 5-17, 18a,b,c,d, 19-42; J 43+; B 1+
Vermont Square Branch, 1201 West 48th St.
Vernon Branch, 4504 Central Ave.
West Los Angeles Branch
J 46+; B 153+
Municipal Reference Library, Water and Power Division, Box 3669, Terminal Annex
Occidental College Library
R 17, 18a,c,d,e,f,g,h,i,j,k,l, 19b,c,d, 20, 21a,b, 22-26, 27c, 28b,c, 29-30, 31d, 32d, 33, 34a,b,d, 35-42; J 43+; B 69, 74, 78-85, 87-91, 93-94, 96-107, 112-118, 122-123, 125-130, 132-133, 137+
University of California at Los Angeles, Geology Dept. Library, 405 Hilgard Ave.*
University of Southern California Library, University Park*

Madera, Madera County
Madera County Free Library
R 8, 14, 17-18, 19a, 20d, 21b, 22a, 23, 24a,c,d, 25a,b, 26a,b,c, 27-28, 29b, 30a,b, 31a,c,d, 32, 33a,b,c, 34-35, 36b,c,d, 37-42; J 43+; B 63, 66-67, 69-72, 76, 78, 84-85, 89, 98, 104, 106, 108, 115, 118, 123-125, 127, 130-135, 138+

Mariposa, Mariposa County
Mariposa Branch Library
J 44c+; B 140+

Martinez, Contra Costa County
Contra Costa County Library, Hall of Records, Rm. 119
M 19; R 24, 25a,b,c, 26-27, 28a,c, 29-42; J 43+; B 72, 76, 85, 103-110, 112-114, 116-117, 119, 121, 124, 126-128, 131+

Marysville, Yuba County
Marysville City Library, 301 4th St., Box 991
R 11-13, 16-42; J 43+; B 2, 6, 9-10, 19, 23, 27, 36-38, 50, 56-57, 60, 63-74, 76-88, 90-91, 93-96, 98-119, 121-137

- Merced, Merced County
  - Merced County Free Library, 2125 M St.
    - R 16, 18i, 19d, 20-28, 29a, 30-31, 32a,c,d, 33, 34a,c,d, 35-36, 37b,c,d, 38-42; J 43+; B 56-57, 60, 63-66, 68-75, 78-88, 90, 93-94, 96-97, 99-107, 109, 112, 114, 117-119, 121-137
- Mills College, Alameda County
  - Mills College Library*
- Modesto, Stanislaus County
  - McHenry Public Library
  - Modesto Junior College Library
    - J 45+; B 144+
  - Stanislaus County Free Library
    - R 14b, 15a, 16, 18-42; J 43+; B 65-68, 70-71, 73-74, 76-79, 83, 85-87, 90-91, 93-94, 96-105, 107-122, 125-126, 128, 131+
- Mojave, Kern County
  - Kern County Free Library, Mojave Branch
- Monterey, Monterey County
  - Monterey Public Library
- Napa, Napa County
  - Napa County Free Library*
- Nevada City, Nevada County
  - Nevada City Free Library
- North Hollywood, Los Angeles County
  - Los Angeles Public Library, Sidney Lanier Branch, 5211 Tujunga Ave.
    - R 39c,d, 40-41, 42a,b,c; J 43+; B 106, 108, 113, 124, 127, 135+
- Oakland, Alameda County
  - Oakland Public Library, 14th and Grove Sts.
    - M 16, 18, 19; RM 8, 14, 17, 20-21; R 1-42; J 43+; B 3-4, 6-7, 16, 18-19, 27, 32, 36-37, 46, 49-50, 53, 56-57, 59, 61-84, 86-88, 90+
- Orange, Orange County
  - Orange Public Library
    - R 31a,d, 37d, 38-42; J 43+; B 99, 122, 130-131, 135-137+
- Oroville, Butte County
  - Butte County Free Library
    - RM 17; R 15b, 16a, 20d, 23-26, 27a,b,c, 28-29, 30a,b, 31, 32b,c,d, 33-35, 36a,b,d, 37-38, 39a,b,c, 40-42; J 43+; B 65, 67-68, 70-71, 74, 76, 78, 83, 85-88, 90-93, 97, 99, 103, 108-111, 113-114, 116-117, 119, 121-123, 126, 130, 132-135
  - Oroville Public Library
    - R 15, 16b, 18c,d,e,f,g,h,j,k,l, 19-21, 22a,b,d, 23, 24a,b,d, 25, 26d, 31d, 32-34, 35a,c,d, 36-40, 41b,c,d, 42; J 43+; B 36, 57, 76, 79, 93-94, 96-97, 100-102, 121, 137
- Oxnard, Ventura County
  - Oxnard Public Library
    - J 44d+; B 141+
- Pacific Grove, Monterey County
  - Pacific Grove Museum, Natural History Library, Forest and Central Aves.
    - J 45+; B 144+
- Palo Alto, Santa Clara County
  - Palo Alto Public Library
    - R 2, 8-9, 11-13, 16-42; J 43+; B 50, 64-65, 67-68, 77-79, 90, 93-94, 98-99, 101-119, 121-123, 125-126, 128-137+
- Pasadena, Los Angeles County
  - California Institute of Technology Library
    - M 16; RM 3, 5-7, 10, 12, 16, 18-20; R 2, 4-14, 16-19, 20a,b,d, 21-42; J 43+; B 2-4, 6, 9-12, 16, 18-19, 23-25, 27-28, 30-35, 39-40, 42-44, 46-47, 49-53, 57-60, 65-66, 68-74, 76-84, 86, 88-94, 97-110, 112-119, 121+
  - Pasadena Public Library, 285 East Walnut Ave.
    - M 16, 18; R 6b, 8, 10-14, 17, 18-42; J 43+; B 3, 5-6, 16, 23, 27, 30, 38, 50, 53, 56-57, 70-79, 83-88, 90-105, 107, 109-126, 128+
- Paso Robles, San Luis Obispo County
  - Paso Robles Public Library
    - J 43c+; B 139+

Petaluma, Sonoma County
Petaluma Public Library
R 11, 34b,c,d, 35a,d, 36, 37d, 38-41, 42a,b,d; J 43+; B 76, 78-79, 91, 95, 108, 113, 135-137+

Placerville, El Dorado County
El Dorado County Free Library (formerly Placerville Public Library)
R 10, 22d, 26c, 27a,b,d, 28, 31c,d, 32a, 33a,d, 34d, 35b,c,d, 36, 37d, 38-41, 42a,b,c; J 43+; B 76, 83, 86, 88, 90-91, 93, 99, 102-107, 111, 116-118, 122-123, 125+

Pomona, Los Angeles County
Mt. San Antonio College Library, Box 801
Pomona College Library*
Pomona Public Library, 380 North Main St.
R 1-3, 5-15, 17, 29-42; J 43+; B 1-6, 9-10, 15, 18-19, 23-24, 27, 30-32, 35-36, 45+

Quincy, Plumas County
Plumas County Free Library*

Randsburg, Kern County
Desert Museum
J 45c+; B 142+
Kern County Free Library, Randsburg Branch

Red Bluff, Tehama County
Tehama County Free Library
R 16, 21-25, 26a,b,c, 27-28, J 43+; B 23, 50, 76, 78-79, 86, 91-92, 99, 101-107, 109, 112, 119, 121, 125-126, 128-132, 135

Redding, Shasta County
California State Division of Mines, Redding district office
M 16, 18, 19; RM 13; R 6-42; J 43+; B 1-2, 4-7, 9-13, 15-16, 19-23, 25-32, 34, 36-61, 63-65, 67-79+
Shasta County Free Library

Redlands, San Bernardino County
A. K. Smiley Public Library*
University of Redlands Library
R 9-15, 18d,e,g,h,i,j,k,l, 19a,b,c, 20, 21b,c,d, 22, 23b,c,d, 24a,b,d, 25-35, 37-38, 40-41, 42b,c,d; J 43+; B 9, 23, 50, 63, 67, 74, 76-79, 83, 86, 88-90, 92-95, 98-99, 101, 103-104, 107-112, 114-117, 119-120, 122-128, 132, 137

Redwood City, San Mateo County
San Mateo County Free Library*

Richmond, Contra Costa County
Richmond Public Library
R 18a,b,c,e,f,g,h,i,j,k,l, 19-21, 22b,c,d, 23-25, 26a,c,d, 27, 28b,c, 29, 30, 31b,c,d, 32b,c,d, 33-42; J 43+; B 37-38, 46, 63, 69, 71-72, 74, 76-77, 83, 86-88, 90, 108, 123, 131+

Riverside, Riverside County
Riverside Public Library
M 16, 18, 19; RM 4, 7, 12-14, 17, 20-21; R 1-5, 6b, 7-21, 23-42; J 43+; B 2-11, 16, 19-33, 36-38, 44-47, 49-60, 62-119, 121+

Roseville, Placer County
Roseville Public Library, 557 Lincoln St.
B 108, 123, 135

Sacramento, Sacramento County
California State Division of Mines, Sacramento District Office
M 16, 18, 19; RM 1-21; R 1-42; J 43+; B 1-2, 4-7, 9-13, 15-16, 18-19, 21-23, 25-34, 36-65, 67-83, 85+
California State Library
Complete file
Sacramento City Library, Reference Dept.
M 18, RM 1-2, 4-11, 14-16, 21; R 1-42; J 43+; B 1-60, 62-72, 74, 76-79, 83, 85-91, 93-105, 107-108, 110-114, 116-126, 128+
Sacramento Junior College Library, 3836 Freeport Blvd.
Sacramento State College Library
J 46b+; B 153+
U. S. Bureau of Reclamation, Dept. of Interior, Att.-Reg. Library, P. O. Box 2511

Salinas, Monterey County
Monterey County Free Library†

Salinas Public Library
R 20a, 36-42 ; J 43+ ; B 113, 118, 121, 123, 127, 131, 135-137+

San Andreas, Calaveras County
Calaveras County Free Library
J 44b+ ; B 139+

San Bernardino, San Bernardino County
San Bernardino County Free Library, 364 Mt. View Ave.
M 18 ; R 17-42 ; J 43+ ; B 6, 37, 50, 53, 63, 65-72, 74-75, 78-79, 83-88, 90-109, 113, 115-118, 121+
San Bernardino Valley College Library
J 45+ ; B 144+

San Diego, San Diego County
San Diego County Free Library, 3532 Meade
San Diego Public Library, Business and Technology Dept., 8th Ave. and E St.
M 18, 19 ; RM 6-7, 10-12, 14, 17-21 ; R 1-42 ; J 43+ ; B 1-11, 13-19, 23-24, 27-28, 30-34, 36-38, 41, 45-47, 49-60, 62+
San Diego State College Library *

San Francisco, San Francisco County
California State Division of Mines, Headquarters Office
Complete file
California Academy of Sciences Library, Golden Gate Park
M 18, R 2-15, 17-42 ; J 43+ ; B 1-6, 9-11, 16, 18-19, 23-24, 27, 30, 32, 36-38, 44-46, 50, 57, 63-119, 121-122, 124+
Mechanics Institute Library, 57 Post St.
R 1-6, 8, 11-42 ; J 43+ ; B 1-7, 9-12, 16, 18-26, 28-31, 36-38, 41-44, 49-76, 78-91, 93-119, 121+
San Francisco Public Library, Civic Center
M 18, 19, RM 1-12, 14-21 ; R 1-2, 4-18, 19a,b,c, 20-42 ; J 43+ ; B 1-6, 10-12, 16, 18, 23-24, 27, 30, 32, 36-38, 41, 44, 46, 49-50, 53, 56-57, 60, 63-123, 125-137
San Francisco State College Library, Buchanan at Waller St.*
U. S. Dept. Agriculture Library, San Francisco Branch, 626 Appraisers Bldg.
R 16, 39b,c,d, 40-42 ; J 43+ ; B 27, 38, 44, 46, 50, 57, 60, 64, 66, 68, 70-72, 74, 76-79, 83, 85+
University of San Francisco Library, 2130 Fulton St.

San Jose, Santa Clara County
San Jose Public Library, 110 South Market St.
R 40-42 ; J 43+ ; B 127+
San Jose State College Library
M 18 ; R 1-12, 29-42 ; J 43+ ; B 2-3, 9-12, 16, 18, 21-23, 25-26, 28-30, 32, 36, 38-48, 50-53, 55, 57-65, 68, 70-72, 74, 76-77, 79, 83, 86, 88, 92-94, 96-104, 106+
Santa Clara County Library, Hall of Justice
R 26a, 29b, 30a,c, 31-42 ; J 43+ ; B 79, 113, 124, 126-127, 131, 135, 137+

San Luis Obispo, San Luis Obispo County
California Polytechnic School Library
J 44d+ ; B 141+
San Luis Obispo Public Library, 690 Monterey St.

San Mateo, San Mateo County
San Mateo Public Library, 129 2nd Ave.
J 43c+ ; B 139+

San Marino, Los Angeles County
San Marino Public Library
J 46b+ ; B 152+

Santa Ana, Orange County
Orange County Free Library, 1104 B West 8th St.
R 11, 20a, 30b, 31d, 32c,d, 33c,d, 34, 35d, 36a, 37b,d, 38-42 ; J 43+ ; B 92, 103-105, 111, 113-118, 122-128, 131+
Santa Ana College Library, 1424 North Bristol
Santa Ana Public Library
R 6, 9, 11-42 ; J 43+ ; B 47, 49, 53-55, 64-65, 74, 76-79, 83, 86, 88, 90-95, 98-99, 102-104, 106-110, 112-116, 118, 121, 123-124, 130+

Santa Barbara, Santa Barbara County
Santa Barbara Public Library
M 16, 18, 19 ; R 2, 6-9, 11-15, 17, 18a,b,c,d,e,f,g,h,i,k,l, 19-21, 22a,b,c, 23, 24c,d,

25-39, 40a,b,d, 41-42; J 43+; B 3-6, 10-11, 19, 30, 44, 46-47, 49-56, 64-65, 67-74, 76-79, 83-84, 86-88, 90-97, 99-119, 121+
Santa Barbara State College Library
M 16, 18; RM 20; R 11, 14, 17, 18g,h,i,j,l, 19b,c,d, 20a,b,d, 21a, 22c, 23a,b,d, 24a,d, 25c, 26a,d, 27b, 28a, 29b, 30b, 31a,c,d, 32-33, 34b,c, 35-38, 39a,b,c, 40-42; J 43+; B 23, 46, 50, 74, 76-77, 79, 83, 86, 88, 90, 98, 99, 101-104, 107, 109-112, 114-119, 121-122, 125-126, 128-132, 135-137
Westmont College Library, 55 La Paz Road
M 18; R 11, 17, 18g,h,i,j,l, 19b,c,d, 20a,b,d, 21a, 22c, 23a,b,d, 24a,d, 25c, 26a,d, 27b,d, 28a, 29b, 30a,b, 31a,b,d, 32-33, 34b,c, 35-42; J 43+; B 50, 76, 79, 98-99, 104, 115, 118, 125, 130-131, 133-137+

Santa Clara, Santa Clara County
Santa Clara University, Varsi Library*

Santa Cruz, Santa Cruz County
Santa Cruz Public Library, Church St.
J 43c+; B 139+

Santa Maria, Santa Barbara County
State Division of Oil and Gas

Santa Monica, Los Angeles County
Santa Monica Public Library, 503 Santa Monica Blvd.
R 16, 18a,b,c,d,e,g,h,i,k,l, 19, 20a,b,d, 21a,b,d, 22a,c, 23-26, 27a,b,d, 28-29, 30d, 31, 32a,d, 33-34, 35a,b,c, 36a,b,c, 37-42; J 43+; B 19, 23, 37, 63, 70, 72-76, 78-84, 86-88, 90-96, 98-102, 104-115, 117-119, 121-122, 124+

Santa Paula, Ventura County
Dean Hobbs Blanchard Memorial Library
M 18; R 17, 36-42; J 43+; B 67, 69, 72, 74, 78-82, 89, 91, 104, 107-111, 113, 118, 122-125, 130-131, 133+

Santa Rosa, Sonoma County
Santa Rosa Free Public Library
R 14a,c,d,f, 15d, 16, 18h,k, 19b,c, 20b,c,d, 21a,b,d, 22-23, 24a,b, 25, 26c,d, 27, 28c, 29-30, 31b,c,d 32-34, 35d, 37-42; J 43+; B 68, 71, 76, 79, 83, 85-86, 88, 90, 93-94, 96-97, 100-105, 107, 110-114, 116, 121-122, 125-137

Scott Bar, Siskiyou County
Scott Bar Branch Library
J 46c+; B 153+

Sonora, Tuolumne County
Sonora Public Library, Box 181
Tuolumne County Free Library

South Pasadena, Los Angeles County
South Pasadena Public Library, 1111 El Centro

Stanford, Santa Clara County
Stanford University Libraries, Documents Division
M 16, 18, 19; RM 1-21; R 1-15, 16b, 17-42; J 43+; B 1+

Stockton, San Joaquin County
College of the Pacific Library*
Stockton Public Library, Market and Hunter Sts.
M 18; RM 2-5, 10-11, 20-21; R 3-30, 31d, 32-42; J 43+; B 1, 3-14, 16-17, 19, 23, 27, 30-34, 36-38, 46-47, 49, 51-60, 64-65, 68, 70-84, 86-90, 92-94, 96-119, 121-130, 132+

Susanville, Lassen County
Lassen County Free Library, Court House
R 3-8, 16-26, 27d, 28-42; J 43+; B 49, 56, 60, 68, 71-108, 110-114, 116-119, 121-123, 135+

Taft, Kern County
Kern County Free Library, Taft Branch

Turlock, Stanislaus County
Turlock Public Library
J 46+; B 153+

Vallejo, Solano County
Vallejo Public Library, Box 272
R 10, 33c, 34a, 37d, 38, 39b,d, 40a,b, 41d, 42a,c,d; J 43+; B 139+

Ventura, Ventura County
  Ventura County Free Library, Box 771
    M 18; RM 7, 11, 14, 18; R 17-18, 19a,b, 20-30, 31a,b,d, 32-35, 36b,c,d, 37b,c,d, 38-39, 40a,b,c, 41-42; J 43+; B 4, 9-10, 12, 21-23, 25-32, 39-44, 47, 50-55, 58-59, 61, 63-65, 68-71, 74, 76-84, 86-119, 121-128, 131+
  Ventura Junior College Library
    R 21-27, 42; J 43+

Visalia, Tulare County
  Tulare County Free Library
    R 3-16, 18j, 20-25, 26d, 27d, 28b, 29, 31c,d, 32a,b, 33a,d, 34a,c,d, 35+; B 2, 5-8, 12, 31, 38, 58-62, 64-66, 68, 70-77, 83, 85-88, 90, 93-94, 96-97, 100-103, 106-107, 113, 118, 120-121, 123, 131+
  Visalia Public Library, Locust and Oak.
    R 24, 25a,b, 26b,c,d, 27-28, 29a, 30c, 31, 32a,c,d, 33, 34a,c, 35a,c,d, 36-42; J 43+; B 53, 57, 63, 66, 76, 79, 85, 87 91-92, 98-99, 104, 108, 121-126, 128+

Weaverville, Trinity County
  Trinity County Free Library
    R 29a, 30b, 31b,c, 33b, 35-42; J 43+; B 98, 104, 107, 117-126, 128+

Whittier, Los Angeles County
  Whittier College Library †
  Whittier Public Library, Greenleaf and Bailey Sts.

Willows, Glenn County
  Glenn County Free Library
    R 2, 18a,b,c,d, 19a,b,c, 21-22, 23a,b,d, 24b,c,d, 25-26, 27a,c,d, 29, 30b,c, 31a,c,d, 32a,c,d, 33-35, 36a, 37d, 38-41, 42a; J 43+; B 71-72, 75-77, 83, 86-88, 90, 94, 96-97, 100-105, 107-109, 112, 114, 117-119, 123-124, 126-128, 132-133+

Woodland, Yolo County
  Yolo County Free Library
    R 40d, 41, 42b,c,d; J 43+; B 67, 71, 74, 76, 91, 99, 118, 124-125, 128+

Yreka, Siskiyou County
  Siskiyou County Free Library

Yuba City, Sutter County
  Sutter County Free Library, Mission Hall
    J 43c+; B 139+

States Other Than California

Alabama

Birmingham
  Birmingham Public Library
    M 19; R 11, 17, 18d,g,h,i,j,k,l, 19, 29b,d, 21-28, 30d, 31b,c,d, 32-42; J 43+; B 9, 23, 50, 74, 76-79, 83, 86, 88, 90-95, 99, 101-103, 105-108, 110-114, 116-119, 121-122, 125+

University
  University of Alabama Main Library
    M 19; RM 1-12, 15-16, 18-19; R 1-5, 6a, 7-13, 15, 17, 18a,b,d, 19d, 20c, 21d, 22a,c,d, 23c, 25a, 27c, 28b, 31b, 33d, 34-37, 42c,d; J 43+; B 1-49, 51-75, 82-94, 96-97, 100-103, 105, 107, 109, 113, 115-117, 119-121, 124, 131, 135-137

Arizona

Phoenix
  Arizona State Department of Mineral Resources, Mineral Bldg., Fair Grounds
    R 36-42; J 43+

Tucson
  Arizona Bureau of Mines, University of Arizona

Colorado

Boulder
  University of Colorado Libraries, Documents Division
    R 2, 4-13, 35c,d, 36a,c,d, 37d, 38-42; J 43+; B 2, 4, 6, 9-11, 23-24, 27, 30, 32, 35-36, 41, 45-46, 49-50, 53, 56-57, 60, 63-68, 93, 97, 102, 104, 113, 115, 118, 123-125, 127+

Colorado, Continued

Denver
Denver Public Library, Science and Engineering Department
R 1-42 ; J 43+ ; B 1-7, 9-11, 13-33, 35-40, 42-46, 48-58, 60+

Golden
Colorado School of Mines Library
M 18, 19 ; RM 3-12, 14-21 ; R 4, 6-42 ; J 43 ; B 1-7, 9-14, 16, 18-19, 21-31, 34, 36-39, 42-46, 50-51, 57-58, 61-71, 73-96, 98-137

Connecticut

Bridgeport
Bridgeport Public Library, 925 Broad St.
R 11-15, 17-25, 37d, 38-39, 40a,b,c, 41-42 ; J 43+ ; B 61, 65, 68, 70-71, 74, 83, 86-88, 90, 93-97, 100-101, 113, 125, 135+

Hartford
Connecticut Geological and Natural History Survey, State Library

New Haven
Yale University Library, Box 1603a, Yale Sta.
R 1-42 ; J 43+ ; B 1-8, 10-14, 16-18, 21-24, 27, 30-32, 36-37, 42-43, 45-60, 63-65, 67, 69+

District of Columbia

U. S. Government
Bureau of Mines Library
M 16, 18 ; RM 3, 8, 10-21 ; R 1-11, 13-17, 20-42 ; J 43+ ; B 3, 5-6, 9, 18-19, 24, 30, 32, 36, 38-47, 50-53, 56-57, 60-79, 83-119, 121-122, 124-127, 130+
Department of Commerce Library, Commerce Bldg.
Library of Congress
National Academy of Sciences Library, 2101 Constitution Ave.
J 46c+ ; B 148+
Securities and Exchange Commission Library
R 40-42 ; J 43+ ; B 127+
Smithsonian Institution Library

Florida

Gainesville
University of Florida Library
R 11, 14, 17, 36b, 39c,d, 40+ ; B 2, 9-10, 19, 23, 32, 36, 38, 46, 50, 53, 56, 60, 63, 65-71, 74, 76-79, 83, 85-91, 93-97, 99, 101-104, 106+

Idaho

Moscow
Idaho Bureau of Mines and Geology, University of Idaho

Illinois

Chicago
Chicago Public Library, Document Division
M 16, 18, 19 ; R 6-13, 18a,b, 20c,d, 21-29, 30a,c, 31-42 ; J 43+ ; B 3, 5-18, 21-24, 27, 30-35, 45-46, 50-55, 57, 76-79, 83-84, 86-105, 107-119, 121-123, 125+
University of Chicago Library
R 1-42 ; J 43+ ; B 2-3, 6, 18-19, 23, 32, 36-37, 45-46, 50 63-119, 121+

Evanston
Northwestern University Library, Documents Dept.
M 16, 18, 19 ; R 2, 7-8, 11-12, 17, 29-42 ; J 43+ ; B 23, 27, 49-59, 53, 63, 65, 68-69, 78-79, 87-92, 98, 101-108, 110, 112-113, 115-119, 121+

Indiana

Bloomington
Indiana University, Geology Library
R 6-7, 11, 33-36, 39-42 ; J 43+ ; B 1, 9, 50, 76-79, 86, 98-99, 104, 106, 108, 113, 115-117, 121, 123, 131, 135-137

Indianapolis
Indiana State Library, 140 North Seventh Ave.
R 1-42 ; J 43+ ; B 2-4, 6, 8-15, 18, 23-24, 50, 63, 68-70, 72, 78-79, 84, 89-91, 97-99, 104, 106-107, 113, 115, 119, 123, 131+

Lafayette
Purdue University Library
J 45b+ ; B 142+

Iowa

Ames
Iowa State College Library
R 9-12, 21-42; J 43+; B 4, 6, 25, 37, 40, 63, 67, 69, 72, 74-86, 88, 100+

Kansas

Lawrence
University of Kansas Library
R 38-42; J 43+; B 122+

Kentucky

Lexington
University of Kentucky, Geology Library, 103 Miller Hall
R 2, 4, 6a, 7-17, 18b,c,d,e,f,g,h,i,j,k,l, 19-28, 29b, 30a,b, 31a,b,d, 32-42; J 43+; B 2-6, 9-11, 16, 19, 23-24, 27, 32, 37, 46, 50, 57, 61 63-65, 67-84, 86, 88-96, 98+

Louisiana

Baton Rouge
Louisiana State University, Geology Library
R 6, 9-11, 13, 17, 18c,g,h, 19d, 21d, 25a, 26a,d, 27a,b,d, 28a,c, 29-42; J 43+; B 3, 5, 9-11, 23, 32, 46, 56-57, 63-66, 68-72, 74, 76-79, 83-97, 99-105, 107-108, 110, 112+

Maryland

Baltimore
Enoch Pratt Free Library, Industry and Science Department
J 43c+; B 139+
Johns Hopkins University, Geology Library

Massachusetts

Boston
Graduate School of Business Administration, Baker Library
J 43+; B 68-70, 73-74, 78-86, 88, 90, 92-98, 100-103, 105, 107, 109-112, 114, 116, 118, 125, 130-132, 135
Boston University, College of Liberal Arts Library, 688 Boylston St.
J 43c+; B 139+
Massachusetts State Library, 341 State House
M 16, 19; R 1-17, 18d,e,f,g,h,i,j,k,l, 19-42; J 43+; B 1-19, 21-25, 50, 73-74, 76-83, 86, 88, 90-95, 98-99, 101-112, 114, 116-119, 121+
Cambridge
Harvard University, Museum of Comparative Zoology Library
Massachusetts Institute of Technology Library, 77 Massachusetts Ave.
M 18; RM 7, B 2, 4-14, 16-42; J 43+; B 1-13, 15-16, 18-19, 21+
Northampton
Smith College Library
J 43+; B 77, 86, 90, 102-108, 115, 117-119, 121, 124, 127, 139+

Michigan

Ann Arbor
University of Michigan General Library
Detroit
Detroit Public Library, Technology Dept., 3201 Woodward Ave.
R 6-7, 9-13, 18-30, 31a,b,d, 32b,c,d, 33, 34b,c,d, 35-42; J 43+; B 3, 7-14, 16, 74, 78-79, 84-108, 110, 112-114, 116-119, 121-128, 131, 133+
East Lansing
Michigan State College Library
R 12, 20-42; J 43+; B 6, 10, 16, 21, 23, 27, 32, 37, 50, 56, 65, 67, 69, 71-72, 74, 76, 78-79, 85, 89-113, 115-119, 121-133, 137+
Houghton
Michigan College of Mining and Technology Library
R 1-13, 18a,d,e,f,g,h,i,j,k,l, 19b,c, 24d, 25-30, 31b,c,d, 32-33, 34c,d, 35a,c,d, 36-42; J 43+; B 3-4, 9-12, 16, 18, 60, 77, 86, 96-97, 101-103, 105-110, 112-114, 116-119, 121-138+

Minnesota

Minneapolis
Minneapolis Public Library, Technical Dept., Hennikin at 10th
R 8-12, 30-42; J 43+; B 1-6, 9, 23-24, 27, 30, 32, 36-38, 46, 69, 71, 79, 84, 88, 90-92, 94-95, 97-103, 105, 107-112, 114, 116-119, 122-124, 126, 128+
University of Minnesota Library
University of Minnesota School of Mines Library
RM 10; R 3-15, 16b,c, 17-28, 29b, 30-32, 33b,c,d, 34, 35a,b, 36b, 37b,c, 38, 39a,b. 40a,d, 41-42; J 43+; B 1-6, 9, 11, 16, 18-19, 23-24, 27, 30, 32, 36-38, 46. 50, 63-104, 106-107, 113, 131, 137
University of Minnesota, Geology Library, Pillsbury Hall
M 18; R 1-42; J 43+; B 1-7, 10-11, 16, 18, 23, 27, 30, 32, 37, 46, 40, 63-71. 73-77, 79, 82, 84-108, 111-119, 121+

Saint Paul
James Jerome Hill Reference Library
M 18; R 16, 29, 32a,b, 31-42; J 43+; B 18, 50, 76, 78-79, 95, 99, 104, 107-119. 121+

Missouri

Columbia
University of Missouri, Geology Library, 113 Swallow Hall
R 18a,c,d,e,f,g,h,i,j,k,l, 19a, 20-42; J 43+; B 5-6, 9, 23, 38, 44, 55, 63, 66, 70. 72, 74, 76, 78-79, 83, 85, 87-105, 107-130, 132-133, 138+

Kansas City
Kansas City Public Library, Document Division
M 16, 19; R 18b,c,d,e,f,g,h,i,j,k,l, 19-25, 26a,c,d, 27-42; J 43+; B 50, 65-66, 70-42, 74-83, 85-90, 93-94, 96-105, 107-119, 121+

Rolla
Missouri School of Mines Library
R 6-14, 17, 18-42; J 43+; B 2-3, 5-6, 9-10, 15, 23-24, 27, 30-32, 37, 41, 46, 49-50, 57, 60+

St. Louis
St. Louis Public Library, Olive, 13th and 14th Sts.
Washington University, Geology Library
M 18, RM 8, 12, 17, 19-21; R 3, 6-33, 34b,c,d, 35a,b,d, 36-42; J 43+; B 2, 5-6, 8-10, 16, 23, 27-32, 37-38, 42-43, 45-46, 50, 55-57, 61-74, 76-79, 83-113, 115-116, 118, 122+

Montana

Butte
Montana School of Mines Library
M 18, 19; RM 11, 21; R 4, 6-42; J 43+; B 2, 4-6, 9-10, 12, 16-17, 19, 22-44, 46-53, 55-119, 121-135, 138+

Missoula
Montana State University Library
R 29-31, 32b, 33-42; J 43+; B 23-24, 27, 30-32, 36, 38, 45-46, 50-74, 76, 78-105, 112+

Nebraska

Lincoln
University of Nebraska Libraries
J 45d+; B 151+

Nevada

Carson City
Nevada State Inspector of Mines
Reno
Nevada State Bureau of Mines and Mackay School of Mines have their library in common at the University of Nevada. (See University of Nevada for holdings.)
University of Nevada, Mackay School of Mines
M 17; R 8, 10-14, 16-24, 25b-28, 29b, 30, 31a,d, 32a,d, 33-35, 36a,c,d, 37a,d, 38+; B 3-6, 8-13, 15-19, 21-22, 24-34, 36, 38-42, 44-74, 76-97, 99-112, 114-116, 118-123, 125, 127-129, 131-133, 137+

New Hampshire

Hanover
Dartmouth College Library
R 1-17, 18f,g,h,i,j,k,l, 19-20, 21b, 22-42; J 43+; B 2, 6, 9-10, 12-18, 21, 23-26,

New Hampshire—Continued

28-39, 32, 36-37, 39-44, 48, 50-53, 55-56, 58-59, 61, 63-65, 68, 70-72, 74-79, 83, 85-88, 90-96, 98+

New Jersey

New Brunswick
Rutgers State University Library
M 16, 18; RM 12-14, 17, 20-21; R 1-17, 18g,h,i,j,k,l, 19a,b,c, 20a,b,d, 21a,b,c, 22b,c, 23a,b,d, 24, 25b,c,d, 26-27, 28a,c, 29, 30a,b, 22b,c, 23a,b,d, 24, 25b,c,d, 26-27, 28a,c, 29, 30a,b, 31-42; J 43+; B 1, 3, 5-9, 11, 13-14, 16, 18, 27, 50, 53-56, 64-65, 68, 70-71, 74, 76-79, 83, 86, 88, 90, 92-95, 98-100, 102-104, 106-109, 113-114, 118-125, 127-133, 135-137+

Princeton
Princeton University Library
R 29-42; J 43+; B 2, 4-6, 9-10, 23-24, 27, 31-32, 37, 46, 50, 56-57, 61-119, 121-126, 131, 135+

New Mexico

Albuquerque
University of New Mexico Library
R 6-7, 10-11, 17, 29b, 30, 31a,b,d, 32-33, 34b,c,d, 35-42; J 43+; B 23, 32, 46, 60, 74, 77, 79, 83, 86, 88, 90, 98-99, 101-104, 107, 109-112, 114-119, 121+

Socorro
New Mexico School of Mines Library
R 28-42; J 43+; B 107+

New York

Albany
New York State Library

Hamilton
Colgate University Library
R 18e,f,g,h,i,j,k,l, 19-20, 21a,b, 22c, 23a,b,d, 24a,b,d, 25c,d, 26a,d, 27a,b,d, 28a, 29-37, 38a,c, 39-40, 41c,d, 42a,b,c; J 43+; B 76, 78-79, 99, 104, 118-119, 121-123, 125-131, 133+

Ithaca
Cornell University Library
M 16; RM 6, 8-9; R 1-14, 17-21, 22b,c,d, 23-42; J 43+; B 1-10, 15-16, 18, 23, 27, 31-32, 36-38, 45-46, 50, 56-57, 63, 65-67, 71+

New York City
Columbia University, Butler Library, Acquisition Dept., South Hall
Columbia University, Engineering Library
Engineering Societies Library, 29 West 39th St.
M 16, 18, 19; RM 6-12, 14-15, 17-20; R 1-42; J 43+; B 1-19, 22-32, 34-39, 41+
Marvyn Scudder Financial Library, South Hall, Columbia University
New York Public Library, 5th Avenue at 42nd Street

North Carolina

Chapel Hill
University of North Carolina Library
M 18; RM 6-12, 14-19; R 2, 4, 6-7, 9-15, 17, 29-30, 31a,b,d, 32, 33a,b,c, 34d, 35d, 36a,c,d, 37c,d, 38, 39b,c,d, 40-41, 42b,c,d; J 43+; B 2, 4, 6, 9-10, 16, 18, 21, 23-25, 27-30, 32-34, 36-38, 41, 44, 46, 49, 53, 56-57, 60, 63-69, 71, 73-74, 76-79, 83-108, 110-111, 113-115, 117, 127, 131, 133+

Durham
Duke University Library
J 44c+; B 136+

Raleigh
North Carolina State College, D. H. Hill Library
R 29-33, 34b,c,d, 35-42; J 43+; B 127+

Ohio

Cincinnati
Cincinnati Public Library, 629 Vine St.
R 40-42; J 43+; B 17, 30-31, 37-39, 50, 57, 63, 65, 67, 69, 72-83, 85-95, 97-99, 101-102, 104, 108, 113, 115, 118, 123-125, 127+
University of Cincinnati General Library
RM 2, 16, 18, 21; R 1-4, 7-14, 25-42; J 43+; B 1, 3-11, 15, 23-24, 27, 31-32,

Ohio—Continued

- 36-38, 42-43, 46, 49-50, 56-57, 61, 63-65, 67-70, 72-75, 77, 84, 86-87, 90-91, 94-95, 98-99, 101-109, 111-112, 114-115, 117-119, 121+

- Cleveland
  - Cleveland Museum of Natural History, Reference Library, 2717 Euclid Ave.
    - R 30a,b, 31-42; J 43+; B 101-107, 115, 118, 125, 131, 133-137
  - Cleveland Public Library, 325 Superior Ave.
- Columbus
  - Battelle Memorial Institute
    - J 46b+; B 152+
  - Ohio State University, Orton Memorial Library
    - R 1-31, 32a,b,c, 33-37, 38+; B 1-6, 11-16, 23-24, 30, 36-41, 44-46, 49-50, 53-57, 60, 63+
- Oberlin
  - Oberlin College Library
- Toledo
  - Toledo Public Library, Technology Dept.
    - R 20a,b,d, 21a,b,c, 22-24, 25c,d, 26-27, 28c, 29-30, 31b,c,d, 32-42; J 43+; B 23, 50, 53, 64-66, 73-74, 76-79, 83, 86-88, 90-96, 98-104, 111, 131, 135-137+

Oklahoma

- Bartlesville
  - Bureau of Mines Library
    - R 40-42; J 43+; B 127+
- Norman
  - University of Oklahoma Geological Library
- Oklahoma City
  - Oklahoma City Carnegie Library
    - J 45d+; B 151+
- Stillwater
  - Oklahoma A. & M. College Library
- Tulsa
  - Tulsa Public Library
    - J 45d+; B 151+
  - University of Tulsa Library, 7th and College
    - R 2, 5-26, 27a,b,d, 28a,c, 29-41, 42a,c,d; J 43+; B 3-11, 16, 21, 23-24, 27, 32, 36-37, 46, 50, 57, 63-111, 113, 115-118, 120-121, 125, 131, 135-137+

Oregon

- Corvallis
  - Oregon State College Library, Serials Division
    - R 29-42; J 43+; B 109+
- Eugene
  - University of Oregon Library
    - M 18, 19; R 4-5, 8-9, 11-13, 16-42; J 43+; B 4-6, 9, 23, 27, 31-32, 46, 50, 57, 61-108, 110+
- Portland
  - Library Association of Portland, 801 S. W. 10th Ave.
    - M 18, 19; RM 1-11, 14, 20-21; R 6-7, 9, 11-42; J 43+; B 2-6, 9-12, 14-16, 18-19, 23-27, 32, 36-37, 45-46, 50, 53-68, 70-72, 74-96, 98-99, 101-119, 121+
  - Oregon State Department of Geoolgy and Mineral Industries, 702 Woodlark Bldg.
    - R 37-42; J 43+; B 118, 120+
- Salem
  - Oregon State Library, State Library Bldg.
    - M 19; R 2, 6-13, 16-42; J 43+; B 3-4, 6-14, 16, 23, 27, 37, 50, 57, 62, 64-67, 69-70, 82-91, 93-119, 121+

Pennsylvania

- Bethlehem
  - Lehigh University Library
    - RM 4, 8, 10, 12, 19-21; R 6-8, 11-15, 18-42; J 43+; B 2-7, 9, 11-16, 23, 27-29, 31-35, 37-38, 46-48, 50, 57, 60, 63-65, 67-72, 74-88, 90-92, 94-105, 107-133, 138+

Pennsylvania—Continued

Philadelphia
Franklin Institute Library
R 2-13, 16-17, 18c,d,g,h,i,j,l, 19, 20a,b,d, 21a,b,c, 22-23, 24a,b,c, 25b,c,d, 26a,b,c, 27, 28a,c, 29-42; J 43+; B 1-6, 8-14, 16-24, 32, 36-38, 44-45, 50, 53-60, 63-78, 82-91, 93, 95, 97-98, 102-104, 106-113, 115-119, 121-123, 125+
Philadelphia Academy of Natural Sciences, 19th and The Parkway
M 16, 18; RM 7; R 3-14, 16-42; J 43+; B 1-4, 6, 9-11, 16, 19, 23, 37-38, 46, 50, 63, 65, 67-69, 72, 74-133, 137+
Philadelphia Free Library, Public Documents Dept., Logan Square
RM 3-8, 10-21; R 11, 17-25, 26a,b,c, 27-42; J 43+; B 1-7, 9-11, 23-25, 27, 30-32, 36-41, 45-48, 50-53, 56-65, 67, 70-88, 90+
University of Pennsylvania Library, 34th St. at Woodland Ave.
R 37-42; J 43+; B 122+

Pittsburgh
Carnegie Library of Pittsburgh, 4400 Forbes St.
M 16, 18, 19; RM 21; R 4, 6, 8-11, 17-42; J 43+; B 1-6, 8-12, 15-46, 50-119, 121-123, 125+

State College
Pennsylvania State College Mineral Industry Library
R 40-42; J 43+; B 127+

Rhode Island

Providence
Brown University Library
J 43+; B 6, 9, 23, 27, 32, 37, 46, 50, 57, 64-79, 83, 85-88, 93-123, 125

South Dakota

Rapid City
South Dakota School of Mines and Technology Library
PR 3, 4, 6, 7; M 16; R 16-42; J 43+; B 27, 50, 57, 58, 63-65, 68, 71-74, 76-79, 83-118, 121-133, 135+

Tennessee

Nashville
Joint University Geology Departmental Library
R 2-17, 18c,d,f,g,h,i,j,l, 19-42; J 43+; B 1-6, 9-12, 16, 18-19, 23-24, 30, 32, 36-39, 44, 46-48, 53, 56-57, 70, 63+

Texas

Austin
University of Texas Bureau of Economic Geology
M 144; R 14, 16-33, 40, 42; J 43+; B 1-20, 23, 37, 50, 69, 74-117, 119, 122-123, 125-126, 128, 130, 132-133, 135, 137+

College Station
Texas A. & M. College, Geology Dept. Library

Dallas
Southern Methodist University
J 43c+; B 139+

El Paso
El Paso Public Library, Carnegie Square

Fort Worth
Fort Worth Public Library
J 45d+; B 149+
Texas Christian University, Mary Couts Burnett Library
R 39c,d, 40b,c,d, 41-42; J 43+; B 127+

Houston
Houston Public Library
Lubbock
Texas Tech. College Library
J 44d+; B 141+

Utah

Logan
Utah State Agricultural College Library
R 32d, 33, 34a,b,c, 35-36, 37a,c, 38c, 39a,b, 40-42; J 43+; B 3, 6, 9, 65, 68, 70-71, 74, 76, 86, 90, 93-94, 103, 106-107, 116-117, 131, 135-137+

Salt Lake City
  U. S. Bureau of Mines Library

Washington

Pullman
  State College of Washington Library, Serials Section
    RM 12; R 1-2, 6-14, 16-18, 29-42; J 43+; B 1-6, 9-11, 15-16, 18-19, 23-24, 32, 37-38, 41, 44-46, 50-51, 53, 56, 60, 63-74, 76-79, 83-112, 114, 116-119, 121-133, 137-138+

Seattle
  Seattle Public Library, 4th and Madison
    M 18; RM 12-13; R 1-14, 15-42; J 43+; B 2-6, 9-11, 15-16, 18, 23, 27, 30, 32, 36-38, 45-46, 49-50, 53-59, 61-131, 133+
  University of Washington Library
    RM 1-10, 12-21; R 1-13, 16-17, 31b,c, 32a, 33b,c,d, 34-37, 38a,b, 39c,d, 40-42; J 43+; B 2, 5-6, 9, 15, 18, 23, 27, 31-32, 36-41, 44-46, 49-50, 53, 56-61, 63-74, 76-79, 83-91, 95, 98-99, 102, 104, 106, 108-118, 123+
  University of Washington, Gifts and Exchanges

Spokane
  Spokane Public Library, Reference Dept., S 18 Cedar St.
    M 16, 19; R 2, 5-11, 13-14, 16, 18-20, 21b,c,d, 22a,b,c, 23a,b,d, 24-28, 31-42; J 43+; B 2, 5-6, 9-10, 19, 23-26, 36-38, 44, 46, 57, 60, 63-114, 116-119, 121+

Tacoma
  College of Puget Sound Library
    J 43+; B 3, 92, 94, 96, 98, 101-102, 108, 111, 117, 139+
  Tacoma Public Library

Wisconsin

Madison
  University of Wisconsin Library, Department of Geology
    M 16; RM 12, 17, 19-20; R 3-17, 18c,d,e,f,g,h,i,j,k,l, 19-42; J 43+; B 1-14, 16-19, 21-23, 28, 30-32, 34-44, 46-48, 50, 53-56, 63-119, 121+

Milwaukee
  Milwaukee Public Library, 8th and Wisconsin

Wyoming

Laramie
  Wyoming State Geological Survey Library, University of Wyoming
    R 11, 28b, 31a, 32, 34b,c,d, 35a, 36-39, 40a,d, 41-42; J 43+; B 4, 25, 85, 91-92, 95, 99-100, 102-106, 108-109, 113, 115-117, 119, 121-122, 126, 128-137

Alaska

College
  University of Alaska Library
    R 11, 16, 18-19, 20b,c,d, 21d, 22b,d, 23-24, 25a,c,d, 26a,b,d, 27, 28a, 30c, 31c, 34b, 36b,c,d, 37d, 38a,b, 39a,d, 40-41, 42b,c,d; J 43+; B 72, 90, 100, 126-128, 131-133, 137

Washington, D. C.

District of Columbia
  U. S. Government
    Bureau of Mines Library
      M 16, 18; RM 3, 8, 10-21; R 1-11, 13-17, 20-42; J 43+; B 3, 5-6, 9, 18-19, 24, 30, 32, 36, 38-47, 50-53, 56-57, 60-79, 83-119, 121-122, 124-127, 130+
    Department of Commerce Library, Commerce Bldg.
    Library of Congress
    National Academy of Sciences Library, 2101 Constitution Ave.
      J 46c+; B 148+
    Securities and Exchange Commission Library
      R 40-42; J 43+; B 127+
    Smithsonian Institution Library

Foreign

Argentina

Buenos Aires
  Direccion General de Minas y Geologia

Mendoza
  Museo de Historia Natural Juan C. Moyano
    J 46b+ ; B 152+

Australia

Adelaide
  Public Library, Museum and Art Gallery
  University of Adelaide, Barr Smith Library
    R 34-42 ; J 43+ B 139+

Kalgoorlie
  Western Australia Chamber of Mines

Melbourne
  Victoria Mining Department, Treasury Gardens

Perth
  Western Australia Geological Survey, Beaufort Street

Sydney
  Public Library of New South Wales
    R 17, 29-42 ; J 43+ ; B 76-94, 96-99, 101-102, 107-112, 114, 116, 118-119, 121, 126, 128-131, 133+

Brazil

Rio de Janeiro
  Department National Da Producao, Mineral-Bibliotheca, Avenida Pasteur, Praia Vermelha

Canada

Ottawa
  Bureau of Geology and Topography Library
  Dept. of Mines and Resources, Bureau of Mines Library, Lydia St.
  Geological Survey of Canada Library, Victoria Memorial Museum Bldg.

Vancouver
  University of British Columbia Library
    R 8-9, 11-12, 16-22, 23b,c,d, 24c, 37a,b,c, 38-42 ; J 43+ ; B 5, 9, 56-57, 63-65, 67-74, 76-77, 79, 83-88, 90-91, 93-97, 100-104, 106+

Czechoslovakia

Bratislava
  Statny Geologicky Ustav, Library, Palisady 46
    R 40d-42 ; J 43+ ; B 129+

Prague
  Statny Geologicky Ustav, Ceskoslovenske Republiky, Hladkov C6, Stresovice
    J 46d+ ; B 148+

England

London
  Geological Society Library, Burlington House, Piccadilly, W. 1
    R 1-4, 6-8, 10-13, 27-42 ; J 43+ ; B 1-5, 11, 16, 50, 77-79, 95, 98-99, 121, 131, 135-137
  Great Britain Geological Survey and Museum, Exhibition Road, South Kensington
  Patent Office Library, 25 Southampton Bldgs., Chancey Lane, W.C. 2
    R 3-15, 17-42 ; J 43+ ; B 1-24, 27, 30-41, 45, 48-54, 56-66, 72, 74, 76, 78-79, 83, 85-86, 88-91, 93-105, 107-123, 125+
  Science Museum Library, South Kensington, S.W. 7
    M 16 ; R 14-15, 18-32, 33a,b,c, 34-42 ; J 43+ ; B 23, 37, 46, 50, 69, 72-73, 75-86, 91+

France

Paris
  Centre National De La Recherche Scientifique, 45 Rue D'Ulm
    R 42 ; J 43+ ; B 135+

Germany

Frieburg
Naturforechende Gesellschaft
J 46+ ; B 152+

Kiel-Wik
Institut für Weltwirtschaft
J 44b+ ; B 136+

Wiesbaden
Hessisches Landesamt für Bodenforschung, Parkstrasse 28
J 46c+ ; B 148+

Hungary

Sopron
A. M. Jozef Nador Muegyetem, Banya, Koho- Es Erdomernoki Kar Konyvtaranak

Italy

Ferrara
University of Ferrara, Institute of Geology
J 46b+ ; B 153+

Japan

Tokyo
The Geological Institute Library, Tokyo University
J 46b+ ; B 153+

Mexico

Mexico
Instituto Geologia De Mexico, Calle Del Cipres 176

Netherlands

Delft
Netherlands Geological and Mining Society, Library, Mijnbouwstraat 20

Peru

Lima
Cuerpo De Ingenieros, De Minas Del Peru, Apartado De Correo 889

Poland

Warsaw
Geological Survey, Library, Rakowiecka St.
J 45b+ ; B 142+

Roumania

Bucharest
Institut De Documentation, Bibl Et Edit Tech, Str. Gabriel, Peri 3
J 45b+ ; B 142+

South Africa

Johannesburg
Transvaal Chamber of Mines, P. O. Box 809

Spain

Barcelona
Real Academia De Ciencias Y Artes De Barcelona, Rambla De Los Estudios, 9
J 43c+ ; B 139+

Oviedo
Instituto De Geologia
J 46b+ ; B 152+

Sweden

Stockholm
Sveriges Geologiska, Undersokning

Uppsala
Universitets Biblioteket
J 44b+ ; B 139+

United States of Soviet Russia

Leningrad
Academy of Sciences of the USSR, Library, Birjevaia Linija 1

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Aaron, C. H.: R 6b; 8
Adams, J. M.: R 6b
Alf, Raymond M.: R 39b
Allen, Alice S.: B 118c
Allen, H. B.: B 118c
Allen, John Eliot: R 37a; B 133
Alvey, Glen: B 152
Anderson, Alden: R 26d
Anderson, Charles A.: R 35c
Anderson, Frank M.: R 28c; B 118b,c
Anderson, Winslow: B 1
Angel, Myron: R 10
Armstrong, J. F.: RM 6
Attwood, Melville: R 2; 5; 8
Atwill, E. R.: B 118c
Aubury, Lewis E.: SP 14; 15; 16; 17; B 53; 56; 57; 60
Aubury, Marion: RM 19
Averill, Charles Volney: R 24c,d; 25a,b, c,d; 27a,b; 29a; 30c; 31c; 32d; 33b; 34b,c; 35b; 37a,b,d; 38a; 39a,b,c,d; 40d, J 43a,d; 46b; 47b; B 135; 139; 141; 142; 156-1
Averitt, Paul: R 41b

Bailey, Edgar H.: R 42c; J 43a; B 147
Bailey, Gilbert E.: RM 11; B 24
Bailey, William C.: B 118c
Bain, H. Foster: B 130
Ballantyne, Richard S.: B 118c
Ballou, F. H. Jr.: J 47a
Barnes, George E.: R 9
Barnes, Roy M.: B 118c
Bateman, Paul C.: R 41d; J 46a
Bauer, Roy M.: B 118a
Beckwith, H. T.: B 118c
Behr, Hans C.: B 9
Birkhauser, Max: B 118c
Blackmar, Charles A.: RM 13
Blackwelder, Eliot: R 28c
Blake, William P.: SP 2; R 2
Boalich, E. S.: PR 3; 4; 5; 7; R 17; 18; B 64; 65; 68; 77
Bodenlos, Alfred J.: J 46b
Bongard, J. F.: M 16
Booth, Edward: R 1
Borden, Granville S.: B 118a
Bowen, Oliver E. Jr.: B 141; 142; 156-3
Bowers, Stephen: SP 11; R 8; 9; 10
Bowes, Glenn H.: B 118c
Bowles, Edgar: B 152
Bowles, Oliver: J 45b
Boyd, James: J 46c
Brown, G. Chester: R 14d,f

Bradley, Philip R. Jr.: B 130
Bradley, Walter W.: R 14b,d; 15e; 18; 20d; 22d; 24,d; 25; 26,a,d; 27; 28,a,c; 29; 30,c; 31,c; 32,d; 33; 34,c,d; 35; 36,d; 37; 38,c; 39; 40,d; 41,d; 42,a,c; B 71; 73; 76; 78; 79; 83; 86; 88; 90; 93; 94; 96; 97; 100; 130; 131
Bramel, Hadley R.: B 130; 144
Bransford, James C.: R 38b
Braun, Lewis T.: B156-2, 3, 4
Brown, J. A.: R 10
Browne, Ross E.: R 9; 10
Bryan, Everett N.: R 28a
Buell, Joseph W.: R 13
Burch, Alfred: R 36b
Burchard, Ernest F.: B 129n
Burgess, John A.: B 141
Burgess, Mary-Louise: J 44d; 47b
Bush, Reed D.: R 20; 21a,b,c,d; 22a,b,c,d; 23a,b,c,d; 24a,b,c,d; 25a,b,c,d; 26a,b,c,d; 27a,b,c,d; 28a,b,c; 29a,b; 30a,b,c; 31a,b,c,d; 32a,b,c,d; 33a,b; B 118a

Canfield, Charles R.: B 118c
Castello, W. O.: PR 4; 5; 7; R 17; B 87
Cater, Fred W. Jr.: B 134, a1, 2, c1, c2
Chambers, L. S.: B 118c
Chandler, John W.: R 37c
Chaney, Ralph W.: R 28c
Charles, Abbott: J 43b
Chesterman, Charles W.: R 38c; J 46a; B 156-3, 4
Church, C. C.: R 27b; B 118b
Clark, Bruce L.: B 118b
Clark, Douglas: R 29a
Clements, Thomas: B 118c
Cloudman, H. C.: R 15f
Cogen, William M.: R 32d
Coghlan, S. R.: B 130
Colby, William E.: J 44c; 45c; 46d
Collins, Beth: J 44d; 47b
Collins, F. W.: B 135
Collom, R. E.: R 18; 19
Cooper, A. S.: SP 10; B 16
Cooper, H. N.: B 31
Cooper, J. G.: SP 8; R 7; 9; B 4
Cox, Doak C.: B 152
Cox, Manning W.: B 144
Crandall, Richard R.: B 118c
Crawford, J. J.: R 12; 13
Creasey, S. C.: R 42a; B 152
Crippen, Richard A. Jr.: J 43a; 44c; B 141; 156-4
Crittenden, Max D. Jr.: B 152
Crook, Theo H.: B 125; 152
Crosby, James W. III: J 47b; B 156-4
Cross, Charles M.: B 118c
Cross, Rodman K.: B 118c
Crossman, James H.: R 9
Cutter, Donald C.: B 141

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Dana, Edward S.: R 5
Davidson, A. V.: RM 7
Davidson, J. M.: RM 3
Davis, C. W.: R 38b
Davis, E. F.: B 152
Davis, Eugene L.: B 118c
Davis, Fenelon F.: J 44b; 46b; 47b; B 139; 142; 156-1, 3
Davis, William Morris: R 29a; J 44 b
De Groot, Henry: R 2; 4; 9; 10
Dibblee, T. W. Jr.: B 118c; 150
Dietrich, Waldemar Fenn: B 99
Dietz, R. S.: J 46a
Dittmar, M. E.: RM 10
Dodge, John F.: B 118a
Doell, E. C.: B 118c
Dolbear, Samuel H.: R 36b; B 130
Dolman, S. G.: R 40a
Donnelly, Maurice: R 30c
Doolittle, J. E.: B 36
Douglas, James M.: B 118c
Dow, D. H.: B 134 b1
Dreyer, Frank E.: B 118b,c
Driver, Herschel L.: B 118c
Dudley, Paul H.: R 31d; B 118c
Dunn, Russell L.: R 8; 9; 11; 12
Durrell, Cordell: R 39b; 40d; B 129*l*

Eakle, Arthur S.: R 15a; B 67; 91
Eaton, J. E.: R 35c; B 118b,c
Eckel, Edwin B.: R 37d; 42b
Eckel, Edwin C.: R 29b
Edman, J. A.: RM 2; 20; B 45
Edwards, Everett C.: B 118c
Egenhoff, Elisabeth L.: J 44d; 45d; 47b; B 118c; 129; 144
Eipper, William E.: J 46c
Eliel, Leon T.: R 26a
Ellsworth, Elmer W.: R 29a
Emery, K. O.: J 46a,b
Engel, René: B 146
Eric, John H.: J 46a; B 144
Erickson, Max P.: J 46a
Erwin, Homer D.: R 30a; 32d; 36c
Everhart, Donald L.: R 42b; J 44c; 46c,d

Fairbanks, Harold W.: R 10; 11; 12; 13
Farmin, Rollin: R 37b
Fenenga, Franklin: B 141
Ferguson, Glenn C.: B 118b,c
Feuchsel, C. F.: R 42d
Fiedler, William Morris: R 40b
Finch, John Wellington: R 32c; 35a; 36a
Fix, Philip F.: R 45a
Follansbee, G. S. Jr.: B 118c
Foote, Arthur B.: R 37c
Foote, Arthur De Wint: R 13
Forbes, J. McLaren: R 39c
Forrest, Lesh C.: B 118b

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Forstner, William: B 27
Fowle, Royal E.: B 133
Franke, Herbert A.: R 26a,d; 28b; 30b; 31d; 32c
Fraser, Donald McCoy: R 27d
Fraser, H. J.: R 38c
Gale, Hoyt S.: R 42d
Galliher, E. Wayne: R 28a
Galloway, John: B 118c
Gardiner, Chester M.: B 118c
Gardner, Dion L.: R 36c
Gardner, E. D.: R 33a; 35c
Gary, George L.: R 35d; 36a; 37b,c,d; 39b; B 124
Gentry, A. W.: B 118c
Gester, S. H.: B 118c
Goldstone, L. P.: R 10
Goodyear, W. A.: R 7; 8; 9; 10
Gore, F. D.: R 19d
Goudkoff, Paul P.: B 118b
Grant, Ulysses S. IV: R 35a; B 118b,c
Grant, William M.: R 18b
Gresswell, W. K.: R 36b
Grinsfelder, S.: B 118c
Gumbinner, Sven: R 9
Gutzkow, F.: R 6b
Gwinn, G. Richards: R 40d
Hadley, Jarvis B.: B 129a; 152
Haley, Charles Scott: R 18a; 19a; B 92
Hamilton, Fletcher McN.: PR 1; 2; 6; 8; R 14; 15; 16; 17; 18; 19; B 66; 70; 75
Hammond, John Hays: R 8; 9; 10
Hammond, R. P. Jr.: R 10
Hanks, Henry G.: R 1; 2; 3; 4; 5; 6
Hanna, G. Dallas: R 18b; 25a; 27b; 32a; B 118b
Harness, Charles L.: R 40a
Harrington, William C.: B 118c
Harris, Lew B.: RM 20; 21
Harvey, Philip: R 2
Hasson, W. F. C.: R 13
Hazenbush, George C.: J 47b
Hazzard, John C.: R 33d
Heikkila, Henry H.: SR 6
Heizer, Ott F.: R 34c
Heizer, Robert F.: R 37b; 40c; B 118a; 141
Helm, Mary Helena: R 41d
Hendry, N. W.: R 38c
Henny, Gerard: B 118c
Henshaw, Paul C.: R 38b
Herman, John: J 44d
Herold, Stanley C.: B 118a
Hertlein, Leo George: R 35a; B 118b,c
Hewett, D. F.: B 129m
Hewitt, R. L.: J 44b
Heyl, George R.: J 45d; B 144
Hidden, William Earl: R 5
Hilgard, E. W.: R 10
Hill, James H: R 19d
Hill, Mason L.: B 118c
Hillis, Donuil: B 118c

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Hilpert, Lowell S.: R 41a; 42c
Hinds, Norman E. A.: R 29a
Hobson, H. D.: B 118c
Hobson, J. B.: R 10; 11
Hodson, William G.: R 11
Hoffman, Samuel R.: B 156-4
Hofstetter, Leonard O.: J 44a
Holman, W. H.: B 118c
Honke, Martin T. Jr.: J 46a
Hoots, Harold W.: B 118b
Hoover, Herbert: R 29b
Hoppin, Richard A.: SR 3
Howard, Paul J.: B 118c
Hubbard, Henry G.: R 39a,b,c
Hubon, Irving A.: RM 14
Hudson, Frank S.: B 125; 152
Huelsdonk, L. L.: B 135
Huey, Arthur S.: B 140
Huguenin, Emile: PR 7; R 15a,e,f; 17; B 76
Hulin, Carlton D.: R 30c; B 95
Hunt, Charles B.: B 152

Ingram, Stuart H.: J 45c
Irelan, Linna: R 9
Irelan, William Jr.: R 6,b; 7; 8; 9; 10; 11
Isaacs, John D.: R 13

Jackson, A. Wendell: R 7; 8
Jahns, Richard H.: SR 4
Janin, Charles: B 57
Jarman, Arthur: R 23a
Jasper, O. W.: RM 17
Jeffery, Joseph A.: R 27c; 39c
Jenkins, Dorothy G.: B 141
Jenkins, Olaf P.: M 17; 18; 19; SP 18; R 26b,c,d; 27a,b,c,d; 28a,b,c; 29a; 30a,c; 31b,d; 32c,d; 33a,b,c,d; 34b,c; 35c,d; 36c,d; 37a,b,c; 38c; 39a,b,d; 40b; 41d; J 43d; 45a; 46a; 47b; B 108; 118,b,c; 125; 129; 130; 133; 134; 135; 141; 142; 144; 156
Jenkins, William O.: R 39b
Jensen, Nan C.: R 40a; J 45b
Johnson, A. C.: B 129o
Johnson, Bertrand L.: R 37b
Johnson, Charles F.: R 31b
Johnson, F. A.: B 118c
Johnson, F. T.: J 45c
Johnson, Harry R.: B 118c
Johnston, William D.: R 9; 10
Johnston, William D. Jr.: R 33d
Joslin, G. A.: B 130

Keiser, Edwin T.: R 20c
Kelley, Vincent C.: R 34d
Kellogg, A.: R 2
Kellogg, John L.: R 35d
Kelly, Junea W.: R 29b
Kerr, M. B.: RM 1
Kett, William F.: J 43b

Note: Please do not order from finding lists; refer to text to see whether publication is still in stock. Out-of-print publications can no longer be obtained from the Division of Mines.

Kew, W. S. W.: B 118c
Keyes, W. S.: R 8
King, Clarence R.: J 44b,c,d; B 139
King, Vernon L.: B 118c
Kirby, Edmund B.: R 13
Kirby, James M.: B 118c
Kleinpell, Robert M.: B 118b
Kluth, Emil: B 118c
Knox, George L.: B 118c
Kribbs, George R.: B 118c
Kroger, Robert Scott: B 125
Krueger, Max L.: B 118c
Kunz, George F.: B 37

Laiming, Boris: B 118b
Laird, Wilson M.: J 45b
Laizure, C. McK: R 17; 18; 19; 20; 21a,b,c,d; 22a,b,c; 23a,b; 24b,d; 25a, b,c,d; 28b; 29c; 30b; 31a; 39a; B 120
Lamey, Carl A.: B 129b,c,d,e,f,g,h,j,k
Lance, John F.: SR 4
Lasky, S. G.: B 152
Ledingham, Glen W.: B 118c
Leggett, Thomas Haight: R 12
Leith, Carlton James: B 147
Lindgren, Waldemar: R 34a
Linsley, Earle G.: R 35c
Little, James M.: R 38c
Logan, Clarence A.: PR 7; R 15e; 17; 18; 19; 20; 21a,b,c,d; 22a,b,c,d; 23b,c; 24a,c; 25b,c; 26b,c,d; 27c,d; 31a; 32a, c; 34c; 37c; 39a; J 43c; 45a; 46b,d; B 76; 85; 108; 127; 138; 141; 142; 156-3, 4
Lowden, W. S.: RM 4
Lowell, F. L.: R 14c,d
Lukens, R. R.: R 34a
Lynton, Edward D.: R 34d

MacBoyle, Errol: R 16a,b,c
MacGinitie, Harry D.: B 118c
Mackenzie, A. G.: R 35b
Mackevett, Edward M.: SR 5
MacLeod, George M.: SR 6
Madeira, George: RM 8
Malozemoff, P.: B 135
Manlove, Charles: B 118c
Manning, George A.: B 148
Marks, Jay Glenn: B 118c
Masson, Peter H.: B 151
Matthews, Philip S.: R 31c
Maxson, John H.: R 29a
May, John C.: J 44b; B 118c
Mayo, Evans B.: R 26d; 29a; 30a
McGillivray, John D.: R 13
McGregor, Alexander: R 10
McLaughlin, R. P.: PR 1; 2; RM 11; 16; R 14d; 15a; B 69; 73; 82; 84
McMasters, J. H.: B 118c
Means, John H.: B 15
Meek, Jason R.: RM 21
Merrill, Charles White: R 34c; 37a
Merrill, Frederick J. H.: R 14e; 15d,f

Note: Please do not order from finding lists; refer to text to see whether publication is still in stock. Out-of-print publications can no longer be obtained from the Division of Mines.

Metzner, Loyde H.: B 118c
Michelin, James: B 118c
Miller, Robert H.: B 118c
Miller, William John: R 31b; 36d; 40a
Miller, William P.: R 10
Miner, J. A.: R 10
Mispley, R. G.: J 45c
Morse, R. R.: B 152
Mulryan, Henry: R 32b
Murdoch, Joseph: R 40c; 42c; J 45d; B 136
Murphy, F. M.: R 28c
Myers, W. Bradley: R 42b; J 44c; B 147

Nelson, J. M.: B 152
Newman, M. A.: R 18; 19
Noble, Earl B.: B 118c
Norbeck, H. P.: B 152
Norman, Lewis A. Jr.: J 47a,b; B 142; 156-3, 4; SR 3
Normile, Thomas: R 18j
North, Edward: R 10

O'Brien, John Charles: R 39a,b,c; 42c; J 43d; 44d; 45c; 46c; 47b; B 142; 156-4
Oakeshott, Gordon B.: R 33c; J 45b; 46a; B 129p; 156-2, 3, 4
Ogle, Burdette A.: B 148
Olmsted, Franklin H.: J 46b
Orcutt, Charles Russell: R 10

Pabst, Adolf: B 113
Page, Lincoln R.: R 42a
Parker, Frank S.: B 118c
Parker, Ivan H.: RM 9
Partridge, John F. Jr.: R 37b
Paul, Almarin B.: R 2
Peck, Albert B.: R 20b
Pemberton, J. R.: B 118a
Penfield, Samuel S.: R 5
Penniman, H. W. H.: RM 1
Petar, Alice V.: R 27a
Petersdorff, F. C. von: R 10
Pierce, W. G.: B 152
Popenoe, Willis P.: B 118c
Popert, William H.: R 41b
Porter, Lawrence E.: B 118c
Porter, William W. II: B 118c
Preston, E. B.: R 9; 10; 11; B 6
Proctor, Paul Dean: J 46a; B 129*l*
Prout, John W. Jr.: R 36d
Prutzman, Paul W.: RM 18; B 32; 63

Ralston, Oliver C.: R 40c
Rand, William W.: R 27b
Randall, P. M.: R 6b
Randol, J. B.: R 6b; 10
Ransome, Alfred L.: R 35d; 36b
Reed, Charles H.: R 35a
Reed, Ralph D.: B 118b
Reese, Richard G.: B 118c
Reiche, Parry: SR 2

Note: Please do not order from finding lists; refer to text to see whether publication is still in stock. Out-of-print publications can no longer be obtained from the Division of Mines.

Ricker, Spangler: R 41a; 45a,c; B 129o; 152
Rice, Salem J.: J 47b
Ricketts, A. H.: R 11; 20b,c,d; 21a; 22c; 25c; 26b; J 44a; 46b; B 98; 106; 120; 123; 127; 138
Ries, Heinrich: J 44a
Rist, Robert L.: B 118c
Robinson, F. W.: R 2
Rogers, Austin Flint: R 28a; 40d
Rogers, R. G.: B 118c
Romanowitz, Charles M.: B 135
Root, Lloyd L.: R 19; 20; 21; 22; 23; 24
Rosaire, E. E.: B 118a
Russell, R. Dana: R 35c
Rynearson, Garn A.: B 134 a1, c3

Salathe, Frederick: R 13
Sampson, Reid J.: R 25d; 26c; 27c; 28a, b,c; 29b; 31d; 33c,d; 34d; 36a,b,c,d; 37d; 38b; 39a,b,d; 41c; J 45b; B 142
Sanborn, Frank: R 22a; 28b; 30b
Sawin, Herbert A.: B 135
Scarborough, H. L.: B 118a
Scheidel, A.: B 5
Schombel, L. F.: B 118c
Schuette, C. N.: R 33a
Searls, Robert M.: R 35a; B 130
Sedelmeyer, H. A.: R 27a; B 118b
Segerstrom, Richard J.: R 37d
Senior, Sam P. Jr.: R 25b
Shedd, Solon: R 35c; B 104; 115
Shepard, Francis P.: R 34c
Shepard, O. Cutler: B 125
Sherman, R. W.: B 118c
Shride, A. F.: B 152
Simons, Frank S.: B 125; 129i; 152
Simonson, R. R.: B 118c
Simpson, Edward C.: R 30c
Smith, James Perrin: B 72
Snedden, Loring B.: B 118c
Somerton, Wilbur H.: J 45b,c,d
Soper, E. K.: R 34b; B 118c
Sperisen, Francis J.: R 34a
Stalder, Walter: R 39c; B 118a
Stern, A. George: R 40c
Stetefeldt, C. A.: R 10
Stevens, John B.: B 118c
Stewart, R. E.: B 118c
Stewart, Richard M.: J 47a,b; B 142; 156-4
Stipp, T. F.: B 118c
Stolz, Harry P.: B 118c
Storms, W. H.: R 11; 12; B 2; 18
Stromquist, Arvid A.: J 46a
Sutherland, J. Clark: R 31a; B 130
Swayze, R. O.: B 118c
Swinney, C. Melvin: J 43a; 45a; 46a,c
Symons, Henry H.: R 26b,c; 28b; 30b; 40c; 47b; B 101; 102; 103; 105; 107; 109; 110; 111; 112; 114; 116; 117; 119; 121; 122; 126; 128; 132; 137; 139; 142; 156-1

Note: Please do not order from finding lists; refer to text to see whether publication is still in stock. Out-of-print publications can no longer be obtained from the Division of Mines.

Taliaferro, N. L.: B 118b,c; 125; 143; 145; 152
Taylor, George F.: RM 15
Thayer, T. P.: B 134 b1
Thomas, F. F.: R 8
Thoms, C. C.: B 118c
Thorndyke, John T.: R 32d
Thorne, W. E.: RM 17
Thorup, Richard R.: B 118c
Tolman, Frank B.: B 118c
Trask, Parker Davies: B 125; 129i; 152
Trauger, Fred D.: B 152
Treganza, Adan E.: R 40c
Tregloan, John B.: RM 12
Tremoureux, Roy E.: B 130
Tucker, W. Burling: PR 7; R 14a; 15b, c,f; 17; 18; 19; 20; 21a,b,c,d; 22b,d; 23a,c,d; 25a,d; 26c; 27c,d; 28c; 29b; 30c; 31d; 34a,d; 35a; 36a,b,c,d; 37d; 38b; 39a,b,d; 41c; 42d; J 45b; B 76
Turner, Mort D.: J 47b; B 156-3, 4
Tustin, E. B. Jr: R 42d
Tyler, Paul M.: R 34b

Uren, Charles E.: RM 5
Uren, Lester C.: B 118a

Valentine, W. W.; B 118c
Van Couvering, Martin: B 118c
Vander Leck, Lawrence: R 18e; B 89
Vanderburg, W. O.: R 31c
Vaughan, F. E.: B 118a
Vernon, James W.: J 47b; 156-2, 3, 4
Ver Planck, William E. Jr.: J 46a; B 142; 156-3
Vickery, Frederick P.: B 118c
Vitaliano, Charles J.: J 46c
Vodges, Anthony W.: B 10; 30
Vonsen, M.: R 32a; 42c

Walker, D. H.: B 51; 52; 54; 55; 58; 59; 61; 62
Walker, George W.: J 45d; SR 1A, 1B
Wanders, H. H.: R 41b
Wardner, William R. Jr.: B 118a
Waring, Clarence A.: M 14; R 15a,b,c,e; B 76
Warner, Thor: R 26a
Warren, Charles R.: B 156
Warren, Earl: J 45c
Waterfall, Louis N.: B 118c
Waterman, Herbert: B 130
Watts, W. L.: R 10; 11; 13; B 3; 11; 19; 20
Weaver, Charles E.: B 118c; 149
Weaver, Donald K.: B 118c
Webb, Robert W.: R 36d; 40c; B 136
Weber, Adolph H.: R 7; 9
Wells, Francis G.: B 134a1, 2
Wharton, J. B.: B 118c
Wheelan, F. H.: R 10
Whiting, H. A.: R 8

Note: Please do not order from finding lists; refer to text to see whether publication is still in stock. Out-of-print publications can no longer be obtained from the Division of Mines.

Wicks, Frank R.: R 27a
Wiebelt, Frank J.: J 45a
Wiese, John H.: R 42a; 45d; 46a; B 153
Wilhelm, V. H.: B 118c
Wilkinson, E. M.: RM 19
Willey, Harry I.: R 9
Williams, Howel: B 151
Williams, R. N.: B 118c
Willis, Robin: B 118c
Wilmarth, M. Grace: B 118c
Wilson, H. D. B.: R 38c
Wilson, Ivan F.: R 39b; B 125; 152
Wiltsee, E. A.: R 11
Winham, W. P.: B 118c
Winston, W. B.: R 37c; 39b; 41c; J 43b,d; 44a; 45a; B 57
Winter, H. E.: B 118c
Winterburn, Read: B 118c
Wisker, A. L.: R 32b
Wissler, Stanley G.: B118b
Woodford, Alfred O.: R 39c; B 152
Woodhouse, C. D.: R 27c
Woodward, A. F.: B 118c
Woodward, W. T.: B 118c
Wright, Charles Will: R 32b
Wright, Lauren A.: J 44a; 47b; B 156-3
Wright, Lawrence B.: R 42a
Wyant, Donald C.: B 144

Yale, Charles G.: R 6b; 11; B 7; 8; 12; 13; 14; 17; 21; 22; 25; 26; 28; 29; 33; 34; 35; 39; 40; 41; 42; 43; 44; 46; 47; 48; 49
Yates, Lorenzo G.: R 9
Yates, Robert G.: R 41a; 42c
Young, Umberto: B 118c

Zimmerman, Erle C.: J 45d

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FINDING LIST OF SUBJECTS

Abbreviations used: M, maps; SP, special publications; PR, preliminary reports; RM, register of mines; R, reports of the State Mineralogist; J, California Journal of Mines and Geology; B, bulletins.

NOTE: PLEASE DO NOT ORDER FROM FINDING LIST; REFER TO TEXT TO SEE WHETHER PUBLICATION IS STILL IN STOCK. PUBLICATIONS MARKED WITH AN ASTERISK (*) ARE OUT OF PRINT AND CANNOT BE PURCHASED FROM THE DIVISION OF MINES.

- Abrasives: B 156-3
- Adamson tungsten mine, Inyo County: R 41d
- Aerial photography, importance to California geologists: R 26a
- Aggregate, for concrete: R 40a
- Agstone, possible uses in California: R 18c
- Airox concrete aggregate: R 40a
- ALAMEDA COUNTY
    - Delta-Mendota canal, geology: SR 2
    - MINES AND MINERAL RESOURCES: R 8; 10; 11; 17; 25d; J 46b
    - Tesla quadrangle, geology: B 140
- Alberhill clay deposits, Riverside County: R 19d
- Alleghany district, Sierra County, quartz mining in: R 18j
- ALPINE COUNTY, MINES AND MINERAL RESOURCES: R 8; 10; 12; 15a; 17; 18h; 27d
- Altitudes, table of California: R 6a; 10
- Altoona quicksilver mine, Trinity County: J 46c
- Aluminum: R 37c; B 156-4
- AMADOR COUNTY
    - chromite: B 134c2
    - Electra and West Point tunnels, geology: J 46a
    - Grayhouse copper area: B 144
    - Ione-Carbondale clays, drilling by U. S. Bureau of Mines: J 45c
    - MINES AND MINERAL RESOURCES: RM 12; R 6b; 8; 10; 11; 14a; 17; 23b
    - Newton copper mine: B 144
- American Eagle-Blue Moon area, Mariposa County: B 144
- American Institute of Mining and Metallurgical Engineers, Warren address: J 45c
- American Potash and Chemical Corp. flow sheet: R 41d
- Anacapa Islands: See Channel Islands
- Andalusite: R 20b; B 156-3
    - deposits, California: R 27c
- Antimony: PR 5; B 156-4
    - deposits, California: R 12; 13
    - Stayton district, San Benito, Santa Clara, and Merced Counties: B 147
- Antioch quadrangle, geology of: B 149
- Arrow mining district, San Bernardino County: R 6a
- Arroyo Grande oil field: B 118c
- Arsenic: B 156-3
    - from Grass Valley: R 33d
- Asbestos: B 156-3
- Asphalt: B 156-3
    - deposits, California: R 7; 10; 12; 13; 18e
    - genesis of California: B 16
    - see also: Bitumen
- Auburn field district, mines and mineral resources: R 17; 19
- Avawatz Mountains, economic minerals of: R 18c

- Bardsdale oil field: B 118c
- Barite deposits, California: R 26a; B 156-3
- Barium: J 45a
- Barstow quadrangle, geology of parts of: R 40a
- Basement complex, Sacramento and San Joaquin Valleys: J 44b
- Beach ridges: J 46b
- Beet sugar industry, limestone in: J 47a

- Belridge oil field: B 118c
- Bentonite: R 37d
- Berryessa Valley, geology and oil possibilities: B 118c
- Beryl: R 27a; 36a
- Beryllium: R 27a; 36a; B 156-3
- Bethany quadrangle, Delta-Mendota Canal in: SR 2
- Beverly Hills oil field: B 118c
- BIBLIOGRAPHY, clay in California: R 23b
  - coal in California: R 18d
  - copper in California: B 144
  - geology and mineral resources of California: R 35c; B 10; 30; 104; 115
  - gold mining, placer: R 28b
  - iron in California: B 129
  - limestone deposits of California: R 18*l*
  - petroleum and natural gas in California: B 118c
- Big Bend zinc-copper mine, Butte County: B 144
- Big Blue mines, geology: R 36d
- Bimetalism: R 6a
- Bismuth: B 156-4
- Bitterwater Creek area, Kern County, geology: SR 6
- Bitumen, use by Indians in California: B 118a
  - see also: Asphalt
- Bituminous rock (sand) deposits, California: R 12; 13; 18e; B 156-3
- Black granite, San Diego County: SR3
- Black sand: R 1; B 156-3
  - auriferous: R 10; B 45; 135
- Blind Spring Hill mining district, Mono County: R 36b
- Blue Lake quadrangle, geology of: B 148
- Blue Moon area, Mariposa County: B 144
- Borates, geology of Kramer district: R 42d
- Borax deposits, California: R 3 pt. 2; 12; 13
  - Nevada: R 3 pt. 2
  - see also: Salines
- Borax Lake: R 32a
- Bradley-San Miguel district, geology and oil possibilities: R 118c
- Buena Vista Hills area, Midway-Sunset oil field: B 118c
- Buhr millstone: R 1
- Building (structural) materials, California: R 1; 6a; 7; 8; 12; 13; B 38
  - Carmel Valley: R 28a
- Building structures of Sierran gold belt: B 141
- BUTTE COUNTY
  - Big Bend zinc-copper mine: B 144
  - MINES AND MINERAL RESOURCES: RM 17; R 6b; 8; 10; 11; 15b; 17; 24c; 26d; J 45c
- Buttonwillow gas field: B 118c

- Cachuma quicksilver district, Santa Barbara County: J 46d
- Cadmium: B 156-4
- CALAVERAS COUNTY
  - ancient channel system: R 12
  - chromite: B 134 c2
  - Copperopolis area: B 144
  - geologic map of portion of Foothill copper belt: R 39d
  - gold mining on Carson Hill: B 141
  - MINES AND MINERAL RESOURCES: RM 1; R 6b; 8; 10; 11; 14a; 17; 21b; 32c
  - Penn zinc-copper mine: J 45a; B 144
  - Quail Hill copper area: B 144
  - quartz crystals from: R 40d
- Calcite, optical: B 156-3
- Calera limestone, San Mateo and Santa Clara Counties: SR 1B
- Calico Mountains, San Bernardino County, geology: R 36c

Note: Please do not order from finding lists; refer to text to see whether publication is still in stock. Out-of-print publications can no longer be obtained from the Division of Mines.

Caliente Range, geology and oil possibilities: R 35c; B 118c
CALIFORNIA, auriferous black sands of: B 45
  bibliography of geology and mineral resources: R 35c; B 10; 30; 104; 115
  building (structural) materials of: B 38
  chromite deposits of: R 1; 12; 13; 37a; B 76; 134
  clay deposits of: PR 7; R 1; 9; 18j; B 99
  commercial minerals of: B 87; 124; 130; 156
  contributions to geology of: SP 2
  copper deposits: R 12; 13; B 23; 50; 144
  counties of: J 47b; B 142
  distances in: R 6b
  economic mineral resources of: B 130; 156
  economic minerals of, map showing: B 118b; 156
  fossils of: R 7; B 4; 118b
  gem minerals of: R 34a; B 37
  geologic formations of: B 72
  geologic map of: B 72; M 1; 18
    legend for: R 31b
    source data: R 33a
  geologic occurrence of mineral resources: B 156
  geologic units of, glossary: B 118c
  geology of: B 118b
  geomorphic provinces of: B 118b; 156
  gold placers of: B 92
  index to topographic quadrangles of: R 41d
  Indian mines and quarries in: R 40c
  industrial materials of: B 38; 156
  iron resources of: B 129
  lakes of: R 29a; J 44b
  limestone deposits of: J 43c
  magnesite deposits of: R 12; 13; B 79
  manganese deposits of: R 12; 13; B 76; 125; 152
  mineral commodities: B 156
  mineral industry, in 1947: J 43d
    progress 1896-99: B 20
  mineral production of: see Statistics, California mineral production
  mineral resources of: R 8; B 156
  minerals for tomorrow: R 42a
  MINERALS OF: SP 12; R 4; 6a; J 45d; B 67; 91; 113; 136
  minerals of, rare: R 2
  mines and minerals of: B 35; 41; 44; 49
  mining in: PR 6; 8
  natural gas in: R 7; 12; 13; B 3; 11; 19; 73; 82; 84; 118
  origin of the name: R 6a
  petroleum in: R 7; 12; 13; 34a; B 3; 11; 19; 63; 69; 73; 82; 84; 89; 118
  placer mining for gold in: B 135
  platinum deposits of: B 85
  progress in mineral industry, 1896-99: B 20
  quicksilver deposits of: R 35d; B 27; 78
  relief map of: M 3; R 27a; B 118b; 156
  resources of: R 4; 5
  saline deposits of: B 24
  soda ash and saltcake in: J 44b
  status of geologic and topographic mapping in: R 40b
  submarine phosphorite off coast of: J 46a
  tin deposits of: R 37d
  tungsten deposits of: R 37b,d
    tabulation to accompany map: R 38c
  war-time mineral industry of: R 41a

Note: Please do not order from finding lists; refer to text to see whether publication is still in stock. Out-of-print publications can no longer be obtained from the Division of Mines.

- CALIFORNIA, NORTHERN
  - circular soil structures in : B 151
  - current mining activity in : R 30c
  - market for chemicals : J 46c
  - oil and gas in : B 118a
- CALIFORNIA, SOUTHERN, current mining activity : R 30c ; 34a ; 36a ; 39b
- California State Department of Natural Resources Act : R 23d
- CALIFORNIA STATE DIVISION OF MINES
  - annual report : See State Mineralogist, Annual Report of
  - consolidated index of publications of : B 131
  - creation of : R 25c
  - geological progress of : 37b
  - Public Resources Code : B 130 ; J 44d
  - publications of the : J 44d ; 45a,b,d ; 47b
- California State Division of Mines and Mining, creation of : R 23d
- California State Mining Board, creation of : R 25c
- California State Mining Bureau, catalogues of the : SP 1 ; 3 ; 4 ; 5 ; 6 ; 7 ; 8 ; 9 ; R 7 ; B 4 ; 77
  - creation and history of : R 1 ; 6a ; 12
  - index to publications of the : B 46
- California State Mining Bureau Act, definition of "mine" and "mineral" for : R 25c
- California State Oil and Gas Supervisor, annual report of : B 73 ; 82 ; 84
- Calistoga silver mines, Napa County : R 6a
- Caminetti Act : R 12 ; 34c ; B 135
- Canal oil field : B 118c
- Cantua-Vallecitos area, geology and oil possibilities : B 118c
- Capitan oil field : B 118c
- Carbon : R 41c
- Carbon-dioxide gas, Imperial County : R 38b
  - Mendocino and northern Sonoma Counties : R 39c
- Carbondale clays, Amador County, drilling by U. S. Bureau of Mines : J 45c
- Cargo Muchacho Mountains, geology and mineral deposits : R 38b
- Carmel Valley, building stone from : R 28a
  - phosphorite from : R 40d
- Carquinez quadrangle, geology of : B 149
- Carrizo Plain, geology and oil possibilities : R 35c ; B 118c
- Carson Hill, mining on : B 141
- Casmalia oil field : B 118c
- Cat Canyon oil field : B 118c
- Catalina Island : see Santa Catalina Island
- Cave Canyon iron-ore deposits, San Bernardino County : B 129e
- Cement : R 8 ; 9 ; B 156-3
- Ceramics : R 9 ; B 99
- Channel Islands, geology of : R 9
- Chemicals, northern California market for : J 46c
- Chino area, San Bernardino County, oil possibilities : B 118c
- Chlorination : see Metallurgy and ore-dressing
- CHROMITE (CHROMIUM, CHROMIC IRON) : PR 3 ; R 38a ; B 156-4
  - costs of mining and concentrating : R 36b
  - DEPOSITS, CALIFORNIA : M 19 ; R 1 ; 12 ; 13 ; 37a ; B 76 ; 134
    - San Luis Obispo County : R 39a
    - Siskiyou County : R 39a
    - Tehama County : R 39a
  - specifications and prices for : R 37d
- Circular soil structures : B 151
- Civil engineering, applications of geology to : R 29a
- CLAY DEPOSITS, Alberhill : R 19d
  - CALIFORNIA : PR 7 ; R 1 ; 9 ; 18j ; B 99 ; 156-3
    - bibliography of : R 23b
  - Ione-Carbondale, drilling by U. S. Bureau of Mines : J 45c
  - Orange County : R 31a

Note: Please do not order from finding lists; refer to text to see whether publication is still in stock. Out-of-print publications can no longer be obtained from the Division of Mines.

- CLAY DEPOSITS—Continued
    - Riverside County : R 31a
    - see also : Bentonite
- Clerbus-Mae tungsten prospect, Trinity County : R 39b
- COAL : B 156-2
    - bibliography of : R 18d
    - DEPOSITS, CALIFORNIA : R 7 ; 9 ; 12 ; 13
- Coal-land law : R 7
- Coalinga oil field : PR 1 ; B 118c
- COAST RANGES, chromite in : B 134b
    - genesis of manganese deposits of : B 125
- COAST RANGES, CENTRAL, geology of : B 118b
- COAST RANGES, NORTHERN, chromite in : B 134 b1
- Cobalt : B 156-4
    - history of the name : R 37c
- Coining precious metals : R 9
- Coke, in California : B 156-2
- Colorado Desert, geology : SP 11 ; R 10
    - mud volcanos in : R 2
- COLUSA COUNTY, geology : R 11
    - MINES AND MINERAL RESOURCES : R 8 ; 10 ; 11 ; 14b ; 17 ; 25c
- Commercial grinding plants, California, directory of : R 26c
- Concentration of ores : see Metallurgy and ore-dressing
- Concrete, Airox aggregate : R 40a
    - decorative effects in : R 27a
- Concretions, biconic : J 44c
    - ironstone : J 46b
- Conejo oil field : B 118c
- Confidence mining district, Tuolumne County, tungsten deposits : R 38c
- CONTRA COSTA COUNTY
    - Antioch quadrangle, geology of : B 149
    - Carquinez quadrangle, geology of : B 149
    - Mare Island quadrangle, geology of : B 149
    - MINES AND MINERAL RESOURCES : R 8 ; 10 ; 11 ; 17 ; 23a
- Convict Basin, Mono County, geology of : R 30a
- COPPER : R 22c ; B 156-4
    - DEPOSITS, CALIFORNIA : R 12 ; 13 ; B 23 ; 50 ; 144
        - Foothill, map showing : R 39d
        - Penn mine : J 45a
        - Shasta County : R 20d
- Copperopolis area, ore deposits : B 144
    - quadrangle, geology : B 145
- Coso Mountains (Range), hot-springs deposits of : R 38c
    - quicksilver deposits of : R 26a
- Counties of California, the : B 142
- County reports on mines and mineral resources : see under each county
- Coyote Hills oil field : B 118c
- Crestmore, minerals of : R 39c
- Cretaceous formations, Santa Ana Mountains : B 118c
- Cuyama Valley, geology and oil possibilities : R 35c ; B 118c
- Cyanide process : see Metallurgy and ore-dressing
- Cyanite deposits, California : R 27c
- Cymric area, McKittrick oil field : B 118c

- Darwin mining district, Inyo County : R 34d
- Debris Commission Act, California : R 12
- DEL NORTE COUNTY, chromite : B 134 a1
    - geology, economic : R 29a
    - MINES AND MINERAL RESOURCES : R 8 ; 10 ; 11 ; 14c ; 17 ; 21c ; 29a
- Del Valle oil field : B 118c
- Delta-Mendota Canal, geology of : SR 2

Note: Please do not order from finding lists; refer to text to see whether publication is still in stock. Out-of-print publications can no longer be obtained from the Division of Mines.

- Desiccated human remains, in California State Mining Bureau: B 1
- Devils Den oil field: B 118c
- Diamonds: R 2
- Diatomaceous earth: R 2
- Diatomite: B 156-3
  - Lompoc deposits: R 32b
- Diatoms, general characteristics of marine and fresh water: R 18b
  - Kreyenhagen shale: R 27b
- Dimension stone, granitoid, San Diego County: SR 3
- Directory, commercial grinding plants in California: R 26c; B 139
  - custom mills in California: B 139
  - foundries in California: R 21d
  - mineral brokers: B 139
  - mineral producers in California: B 105; 107; 109; 110; 111; 112; 114; 116; 117; 119; 121; 122; 126; 128; 130; 132; 137; 139
  - quicksilver buyers: B 139
  - smelters purchasing California metals: B 139
  - testing laboratories and assayers: B 139
- Dolomite: B 156-3
  - industrial uses of: J 45b
- Dominguez oil field: B 118c
- Dry Canyon quadrangle, geology: R 34b
- Dudley Ridge gas field: B 118c
- Duxbury Point region, geology and oil possibilities: B 118c

- Eagle Bird mine, Nevada County, lawsuit: R 10
- Eagle Mountains iron-ore deposits, Riverside County: B 129a
- EARTHQUAKES, doing something about: R 34a
  - Mission-period, 1769-1838: R 37b
  - Owens Valley, 1872: R 8
- East Fork mining district, Trinity County, gold lodes: R 18f
- Economics, mineral: see Mineral economics
- Edison oil field: B 118c
- Edna (Arroyo Grande) oil field: B 118c
- EL DORADO COUNTY
  - geology: R 12
  - Lilyama and Pioneer copper mines: B 144
  - MINES AND MINERAL RESOURCES: RM 6; R 6b; 8; 10; 11; 15c; 17; 22d; 34c
- El Segundo oil field: B 118c
- Electra tunnel, Amador County, geology: J 46a
- Electric-power plants, California: R 13
- Electricity, use in mining: R 12
- Electrum, occurrence in California: R 1
- Elephant as they saw it: J 45d
- Elizabeth Lake quadrangle, geology and mineral resources: R 30c
- Elk Hills oil field: B 118c
- Elwood oil field: B 118c
- Eocene formations, foraminiferal correlation of: B 118b

- Fairfield Knolls gas field: B 118c
- Fairview chromite deposit, Siskiyou County: R 39a
- Fauna, Recent, Mollusca of Channel Islands: R 9
  - west North American shells: SP 8
- Feldspar: B 156-3
  - deposits, California: R 27c
  - tariff rate change on: R 28a
- Ferro-alloys: B 156-4
- Flora, Recent, Channel Islands: R 9
  - forest trees of California: R 2
- Fluorescent minerals, used in lighting: R 40c
- Fluorspar: R 41c; B 156-3
- Foothill copper-zinc belt: B 144

Note: Please do not order from finding lists; refer to text to see whether publication is still in stock. Out-of-print publications can no longer be obtained from the Division of Mines.

- Foraminifera, California : B 118b
- Forest Hill Divide, geology of : R 10
- Fossils, catalogue of California : R 7 ; B 4
  - characteristic of California : B 118b
  - value as mineral indicators : R 9
- Foundries, California, directory of : R 21d
- Foundry sands, California : R 21b ; J 44a
- FRESNO COUNTY, chromite deposits of eastern : B 134c3
  - geology Twin Lakes region : R 38c
  - MINES AND MINERAL RESOURCES : R 6b ; 8 ; 10 ; 11 ; 14d ; 17 ; 25c
  - New Idria district quicksilver deposits : R 39a ; 42b
  - Oil City oil fields, map of : B 15
- FRESNO COUNTY, NORTHWESTERN, quicksilver deposits of : R 41a
- Fruitvale oil field : B 118c

- Galena, deposits of argentiferous : R 12 ; 13
- Gas, carbon-dioxide : see Carbon-dioxide gas
- Gas, natural : see Natural gas
- Gato Ridge area, Cat Canyon oil field : B 118c
- Gaviota-Concepcion area, oil possibilities : B 118c
- Gaviota quadrangle, geology of : B 150
- Gazelle region, Siskiyou County, limestone in : J 45d
- Gem minerals, California : R 34a ; B 37 ; 156-3
- GEOLOGIC GUIDE BOOK SERIES
  - Highway 49 : B 141
  - Mother Lode country : B 141
- Geologic mapping, status in California : R 40b
- Geologic units of California, glossary of : B 118c
- GEOLOGICAL MAPS : see Maps, geologic
  - surveys, State : J 45b
- GEOLOGY, application to civil engineering : R 29a
  - placer deposits : 31b
- GEOLOGY, COUNTY : see under name of county
- GEOLOGY, ECONOMIC, Big Blue mines, Kernville : R 36d
  - Blind Spring Hill mining district, Mono County : R 36b
  - Cargo Muchacho Mountains : R 38b
  - dimension stone, granitoid, San Diego County : SR 3
  - see also under names of individual minerals and rocks
- GEOLOGY, ENGINEERING
  - Delta-Mendota Canal : SR 2
  - Electra and West Point tunnels, Amador County : J 46a
  - Mono Craters tunnel : R 36b
- GEOLOGY, MINERAL DEPOSITS : see under name of mineral
- GEOLOGY, PHYSIOGRAPHIC, ancient surface in Sierra Nevada : R 30a
  - circular soil structures : B 151
  - glaciation of Sierra Nevada : R 28c
  - landslides of Lone Mountain : R 32d
- GEOLOGY, REGIONAL
  - Antioch quadrangle : B 149
  - Barstow quadrangle : R 40a
  - Berryessa Valley : B 118c
  - Bitterwater Creek area, Kern County : SR 6
  - Blue Lake quadrangle : B 148
  - Bradley—San Miguel district : B 118c
  - Calico Mountains : R 36c
  - Caliente Range, Cuyama Valley, Carrizo Plain : R 35c ; B 118c
  - Cantua-Vallecitos area : B 118c
  - Carquinez quadrangle : B 149
  - Coast Ranges : B 125
    - central : B 118b
  - Colorado Desert : SP 11 ; R 10
  - Copperopolis quadrangle : B 145
  - Coso Mountains : R 38c

Note: Please do not order from finding lists; refer to text to see whether publication is still in stock. Out-of-print publications can no longer be obtained from the Division of Mines.

GEOLOGY, REGIONAL—Continued

- Duxbury Point: B 118c
- Elizabeth Lake quadrangle: R 30c
- Foothill copper belt: R 39d
- Forest Hill Divide: R 10
- Gaviota quadrangle: B 150
- Halfmoon Bay district: B 118c
- Hollister quadrangle: B 143
- Huasna area: B 118c
- Humboldt County, central and southern: B 118c
- Julian-Cuyamaca area: R 42a
- Jurupa Mountains: SR 5
- Kernville quadrangle: R 36d
- Lake Elsinore quadrangle: B 146
- Lompoc quadrangle: B 150
- Los Olivos quadrangle: B 150
- Macdoel quadrangle: B 151
- Mare Island quadrangle: B 149
- Mono County, southwestern: R 26d; 30a
- Mother Lode: R 10; 13; 28c; B 18; 108; 141
- Mount Diablo: B 118c
- Mount Vaca quadrangle: B 149
- Needles-Goffs: R 40a
- Neenach quadrangle: B 153
- Newberry and Ord Mountains: R 36c
- Palm Springs-Blythe strip: R 40a
- Panamint Range: R 28c
- Paskenta region: B 118c
- Peninsular Range, southern: R 31b
- Perris block: R 31d
- Petaluma district: B 118c
- Petaluma quadrangle: B 149
- Point Arena-Fort Ross region: B 118c
- Point Arguello quadrangle: B 150
- Point Conception quadrangle: B 150
- Point Reyes quadrangle: B 149
- Quien Sabe quadrangle: B 147
- Randsburg quadrangle: B 95
- Redding-Weaverville district: R 29a
- Rumsey Hills area: B 118c
- San Benito quadrangle: R 39b
- San Diego County, southwestern: R 35a
- San Francisco Bay, area north of: B 149
- San Gabriel Mountains, western: R 33c
- San Jacinto quadrangle: R 27d
- San Jose Hills, western: J 46b
- San Juan Bautista quadrangle: B 133
- Santa Barbara County, southwestern, geology of: B 150
- Santa Cruz Island: R 9; 27b
- Santa Maria river: R 10
- Santa Monica Mountains, central: R 34b
- Santa Rosa Mountain area: R 42a
- Santa Rosa quadrangle: B 149
- Shasta quadrangle: R 27a
- Tesla quadrangle: B 140
- Sierra Nevada: B 125; 141
  - northeast of Visalia, Tulare County: R 39b
- Sierra Nevada, northern: R 28c
- Sites region: B 118c
- Soledad quadrangle: B 118c
- Sonoma quadrangle: B 149

Note: Please do not order from finding lists; refer to text to see whether publication is still in stock. Out-of-print publications can no longer be obtained from the Division of Mines.

- GEOLOGY, REGIONAL—Continued
  - Twin Lakes area, Fresno County: R 38c
  - Vacaville quadrangle: B 149
- GEOLOGY, STRATIGRAPHIC, basement complex, Sacramento and San Joaquin Valleys: J 44b
  - California: B 118b
  - Cretaceous formations, Santa Ana Mountains: B 118c
  - Knoxville-Shasta succession: R 28c
  - Mesozoic in California: B 118b
  - Paleozoic section, Nopah-Resting Springs region: R 33d
  - Rincon Hill well, San Francisco: R 10
  - Tertiary formations, northern Sacramento Valley: R 35c
  - Tertiary in California: B 118b
- Geochemical prospecting, for petroleum: B 118a
- Geomagnetic methods of tracing buried river channels: R 29a
- Geomorphic provinces of California: B 118b
- Geophysical studies in California: B 118a
- Georgia, gold mines of: R 5
- Geysers, The, minerals at: R 42c
  - radioactivity in gases: R 18j
- Ghost Canyon tungsten claims, Madera County: R 38c
- Gibson area, Midway-Sunset oil field: B 118c
- Glacial stream deposits, Sierra Nevada: R 28c
- Glass, manufacture in California: R 9
- GLENN COUNTY, MINES AND MINERAL RESOURCES: R 11; 14b; 17; 25d
- GOLD: R 2; 5; B 156-4
  - discovery in California: B 141
  - in California: R 34a
  - price of: R 37c
  - prospecting for: R 28b; 29a; 33a
  - statistics, number of men mining: R 9
  - uses, refining and coining: R 9
  - GEOLOGY OF LODE, Mother Lode region: R 10; 13
    - quartz veins, formation of: B 141
    - wall rocks of veins: R 8
  - GEOLOGY OF PLACER: R 9; 12; 28c; B 92; 135
    - channels of Duncan Canyon region, Placer County: R 21c
    - channels of Forest Hill Divide: R 10
    - Mojave Desert: R 30c
    - new technique applicable to study of: R 31b
    - primary and secondary concentrations: R 19a
    - Tertiary sluice robbers: R 18j
- GOLD DEPOSITS, black sands: R 10; B 45; 135
  - CALIFORNIA: R 12; 13; B 135
  - East Fork mining district, Trinity County: R 18f
  - Kern County: R 29b
  - Meadow Lake district, Nevada County: R 32b
  - Mother Lode: B 108
  - Placer County: R 32a
  - Redding-Weaverville district: R 29a
  - southern California: R 28b
  - see also: particular localities—counties, states, districts, etc.
- GOLD MINING
  - Carson Hill, Calaveras County: B 141
  - east-central California: R 31a
  - history of California: J 45d; B 141
  - San Francisco district: R 31a
  - LODE: R 9; 10
    - on Carson Hill: B 141
    - sampling deposits: R 30a

Note: Please do not order from finding lists; refer to text to see whether publication is still in stock. Out-of-print publications can no longer be obtained from the Division of Mines.

GOLD MINING—Continued
  PLACER: R 2; 9; 30b; B 135
    beach: R 10
    bibliography on: R 28b
    booming: R 29b
    dams for debris control: R 31c
    dragline dredging, Siskiyou County: R 37b
    dredging: R 34b; B 36; 57
    drift: R 2; 8; 9
    dry-: R 18g
    history of California: B 141
    hydraulic: R 2; 23a
    hydraulic ejectors: R 11
    machines for: R 25a; 28b
    power shovels: R 32c
    river: R 9
GOLD ORES, costs of trucking and packing in western districts: R 35c
  TREATMENT OF, Belmont-Shawmut mine, Tuolumne County: R 18*l*
    chlorination: R 6b
    concentration: R 6b
    cyanidation: R 10; 27b; 34c; B 5
    flour gold: R 2
    hydrometallurgy: R 8
    milling: R 2; 6; 9; 30b; B 6
    tests for determining quality: R 5; 6b; 12
Goler mining district, Kern County: R 12
Goleta oil field: B 118c
Goose Lake meteorite: R 35c
Gorman district, Kern County, tin deposits of the: R 42a
Granite Rock Co. quarry and plant, San Benito County, operations: B 133
Granitoid dimension stone, San Diego County: SR 3
Graphite: PR 5; B 156-3
Gravel: B 156-3
Grayhouse copper area, Amador County: B 144
Greeley oil field: B 118c
Grinding plants, commercial, directory of: R 26c
Ground-water, Santa Maria river: R 10
Guerneville district, quicksilver deposits: J 44c
Guidebooks: See Geologic guidebook series
Gypsum deposits, California: R 12; 13; 18e
Halfmoon Bay district, geology and oil possibilities: B 118c
Hanksite: R 5
Health and safety work, U. S. Bureau of Mines: J 46c
Highway 49, geologic guidebook along: B 141
Hirz Mountain iron-ore deposits, Shasta County: B 129j
Hollister quadrangle, geology of: B 143
Huasna area, geology: B 118c
Human remains, desiccated, in California State Mining Bureau: B 1
HUMBOLDT COUNTY
  Blue Lake quadrangle, geology: B 148
  central and southern, geology and oil possibilities: B 118c
  MINES AND MINERAL RESOURCES: R 8; 10; 11; 14c; 17; 21c; 37d
Huntington Beach oil field: B 118c
Hydraulic mining: see Gold mining, placer
Hydraulic Mining Commission, report on resumption of hydraulic mining: R 23a
Hydromagnesite, analysis of: R 6b

Idaho-Maryland mine, occurrence of scheelite in: R 37b
Imperial carbon dioxide gas field, Imperial County: R 38b
IMPERIAL COUNTY, MINES AND MINERAL RESOURCES: R 14e; 17; 20b; 22b; 38b

---

ρ Note: Please do not order from finding lists; refer to text to see whether publication is still in stock. Out-of-print publications can no longer be obtained from the Division of Mines.

- Indians, use of bitumen by California: B 118a
    - mines and quarries of California: R 40c
- Inglewood oil field: B 118c
- INYO COUNTY, geology: M 14; R 8
    - Millspaugh iron deposit: R 42d
    - MINES AND MINERAL RESOURCES: RM 7; R 8; 10; 12; 15a; 17; 20c; 22d; 34d; J 47a
    - Pine Creek and Adamson tungsten mines: R 41d
    - quicksilver deposits in Coso Range: R 26a
    - Resting Springs region, geology and mineral resources: R 33d
    - Tungsten Hills, geology and tungsten deposits of: J 46a
- Ione-Carbondale clays, Amador County, drilling by U. S. Bureau of Mines: J 45c
- IRON: B 156-4
    - DEPOSITS, CALIFORNIA: R 1; 2; 12; 13; 18c; B 129
    - Millspaugh and Tiefort Mountains: R 42d
- Iron Hat iron-ore deposits, San Bernardino County: B 129g
- Iron King iron-ore deposit, San Bernardino County: B 129c
- Iron Mountain iron-ore deposits, Madera County: B 129i
    - San Bernardino County, Lava Bed district: B 129b
        - Silver Lake district: B 129c
- Ironclad iron-ore deposits, San Bernardino County: B 129g
- Isometrograph, development and use at New Idria mine: R 39c

- Jamesburg quadrangle, geology: R 40b
- Jesse Belle copper mine, Madera County: B 144
- Julian district, San Diego County: R 30c
- Julian-Cuyamaca area, San Diego County: R 42a
- Jurupa Mountains, geology: SR 5

- KERN COUNTY
    - Bitterwater Creek area: SR 6
    - geology: R 8
    - gold resources: R 29b
    - Gorman district, tin deposits of: R 42a
    - Kramer borate district: R 42d
    - MINES AND MINERAL RESOURCES: RM 18; R 8; 10; 11; 14d; 17; 19d; 20a; 25a; J 45b
    - Walibu quicksilver mine: J 43a
- Kern River oil field: RM 18; B 118c
- Kernville quadrangle, geology and mineral resources: R 36d
- Kettleman Hills oil fields: B 118c
- KINGS COUNTY, MINES AND MINERAL RESOURCES: R 14d; 17; 26d; 31d;
- Kingston Range, iron-ore deposits in B 129m
- Klamath Mountains province, chromite in: B 134a
- Knoxville district, quicksilver deposits of the: R 41b
- Knoxville-Shasta succession, Jurassic and Cretaceous divisions in: R 28c
- Kraemer area, Richfield oil field: B 118c
- Kramer borate district, Kern County: R 42d
- Kreyenhagen shale: R 27b
- Kyanite: B 156-3

- La Goleta gas field: B 118c
- La Victoria copper mine, Mariposa County: B 144
- Ladd chromite deposit, Siskiyou County: R 39a
- LAKE COUNTY, geology: R 11
    - Knoxville district, quicksilver deposits: R 41b
    - Mayacmas district, quicksilver deposits: R 42c
    - MINES AND MINERAL RESOURCES: RM 8; R 8; 10; 11; 14b; 17; 25c; J 43a
    - Sulphur Bank quicksilver mine: R 42b
- Lake Elsinore quadrangle, geology of: B 146
- Lake Hawley iron-ore deposits, Sierra County: B 129*l*
- Lakes, alkaline: R 1
    - California: R 29a; J 44b
- Landslide, Lone Mountain: R 32d

Note: Please do not order from finding lists; refer to text to see whether publication is still in stock. Out-of-print publications can no longer be obtained from the Division of Mines.

- LASSEN COUNTY, MINES AND MINERAL RESOURCES: R 8; 9; 10; 11; 15b; 17; 25a 32d
- Laurel Basin, Mono County, geology: R 30a
- Lava Bed district, iron-ore deposits in: B 129b
- Lava Cap Gold Mining Corp., mining methods and costs at: R 37c
- Law, mining: see Mining law
- Lawndale oil field: B 118c
- Lead: B 156-4
  - see also Galena, argentiferous
- Lead ores, treatment of, smelting: R 8; 10
- Leviathan mine, Alpine County, sulphate minerals at: R 35d
- Lilyama mine, El Dorado County: B 144
- Lime: B 156-3
- Limestone: B 156-3
  - agricultural (agstone), possible uses in California: R 18c
  - industrial uses of: J 45b; 47a
- LIMESTONE DEPOSITS, CALIFORNIA: J 43c
  - bibliography of California: R 18*l*
  - Calera, San Mateo and Santa Clara Counties: SR 1B
  - Gazelle region, Siskiyou County: J 45d
  - McCloud River, Shasta County: R 19b
  - San Francisco region: R 28b
  - Sierra Blanca, Santa Barbara County: SR 1A
  - Sonora region, Tuolumne County: J 45d
- Lompoc diatomite deposits, Santa Barbara County: R 32b
- Lompoc oil field: B 118c
- Lompoc quadrangle, geology of: B 150
- Lone Mountain landslides: R 32d
- Long Beach oil field: B 118c
- Los Alamos oil field: RM 20
- Los Angeles basin, oil-producing zones of: B 118b
- Los Angeles City oil field: RM 13; B 118c
- LOS ANGELES COUNTY, geology: R 8
  - MINES AND MINERAL RESOURCES: R 8; 9; 10; 11; 15d; 17; 23c; 33c
  - oil and gas yielding formations in: B 11
  - oil as fuel in: R 13
  - Placerita oil field, geology of: J 46a
  - San Gabriel Mountains, geology and mineral deposits: R 33c
  - San Jose Hills, geology and oil prospects: J 46b
  - titaniferous iron-ore deposits: B 129p
- Los Angeles field district, mines and mineral resources: R 17; 19; 39a
- Los Flores quadrangle, geology: R 34b
- Los Olivos quadrangle, geology of: B 150
- Lost Hills oil field: B 118c
- Lumber, in California: R 2

- Macdoel quadrangle, geology: B 151
- MADERA COUNTY
  - geology: R 12; 30a
  - Jesse Belle copper mine: B 144
  - Minarets district: R 22d; B 129i
  - MINES AND MINERAL RESOURCES: R 14d; 17; 24d; J 46d
  - tungsten deposits: R 38c
- MADERA COUNTY, NORTHEASTERN, geology and mineral resources: R 30a
- Magnesite: R 37b; B 156-3
  - California deposits: R 12; 13; B 79
  - marketing of: R 40a
  - Needles deposit, San Bernardino County: J 46c
  - Red Mountain district: J 46b
- Magnesium: B 156-3
  - compounds: B 156-3
- Mammoth tusks, from Oroville region: R 25a

Note: Please do not order from finding lists; refer to text to see whether publication is still in stock. Out-of-print publications can no longer be obtained from the Division of Mines.

- MANGANESE: PR 3; R 37b; B 156-4
  - specifications and prices for: R 37d
- MANGANESE DEPOSITS
  - CALIFORNIA: R 12; 13; B 76; 125; 152
  - Ladd-Buckeye area near Tracy: R 39a
  - San Mateo County: R 39b
- Map Information Office, U. S. Geological Survey: R 42d; J 43c
  - Symbols used in U. S. Geological Survey publications: J 45a
- MAPS, showing desert fissure springs, San Bernardino County: RM 11
  - showing distribution of auriferous gravels: B 92
  - showing distribution of mineral deposits in California: M 13; F 40b; B 130; 156
  - showing dredging lands adjacent to Feather River: RM 17
  - showing dredging lands in vicinity of Marysville: RM 21
  - showing economic minerals of California: B 118b
  - showing forest reserves of California: M 2
  - showing geologic quadrangles published by Division of Mines: B 133
  - showing geomorphic provinces of California: B 156
  - showing mountains of Mojave Desert: RM 11
  - showing possible oil lands in California: B 89
  - showing private land grants in California: M 1
  - showing progress of topographic and geologic mapping in California: R 40b; B 130
  - showing rivers and creeks that produced placer gold in 1932: M 16; B 135
  - showing saline deposits in southern California desert regions: M 15
  - showing Tertiary gravel channels, Nevada County: B 135
  - showing topography and mineral deposits: M 3
- MAPS, ECONOMIC MINERAL SERIES, No. 1, quicksilver: M 18
  - No. 2, oil and gas: B 118c
  - No. 3, chromite: M 19
  - No. 4, tungsten: R 38c
  - No. 5, manganese: B 125
  - No. 6, copper: B 144
- MAPS, GEOLOGIC, Amador County, western: RM 12
  - ancient channels, between San Andreas and Mokelumne Hill: R 12
  - ancient channels, Calaveras County: R 12
  - CALIFORNIA: M 1; 17; B 72
  - Dry Canyon quadrangle: R 34b
  - Elizabeth Lake quadrangle: R 30c
  - Foothill copper belt: R 39d
  - Forest Hill Divide: R 10
  - Inyo County: M 14
  - Iowa Hill mining district: R 10
  - Jamesburg quadrangle: R 40b
  - Kernville quadrangle: R 36d
  - Los Flores quadrangle: R 34b
  - Mariposa County, northwestern: RM 19
  - Mayacmas quicksilver district: R 42c
  - Mother Lode region: R 10; B 108
  - Perris block: R 31d
  - Plumas County: R 33b
  - Red Bluff quadrangle: R 29a
  - Redding quadrangle: R 29a
  - San Benito quadrangle: R 39b
  - San Diego, Orange, San Bernardino Counties, portions of: R 11
  - San Juan Bautista quadrangle: B 133
  - Santa Monica Mountains: R 34b
  - Shasta County: R 11
  - Sierra County, western: RM 15
  - Sierra Nevada, northern, showing Tertiary channels and Mother Lode: R 28c; B 135
  - Siskiyou County auriferous conglomerate: R 12
  - Topanga Canyon quadrangle, western: R 34b

Note: Please do not order from finding lists; refer to text to see whether publication is still in stock. Out-of-print publications can no longer be obtained from the Division of Mines.

- MAPS, GEOLOGIC—Continued
  - Trinity County: R 10
  - Tuolumne County, southwestern: RM 16
  - Weaverville quadrangle: R 29a
  - Yuba County: RM 21
- MAPS, GEOLOGIC QUADRANGLE SERIES (UNCOLORED)
  - Elizabeth Lake: R 30c
  - Kernville: R 36d
  - San Jacinto: R 27d
  - Weaverville: R 29a
- MAPS, GEOLOGIC QUADRANGLE SERIES (IN COLOR)
  - Antioch: B 149
  - Blue Lake: B 148
  - Carquinez: B 149
  - Copperopolis: B 145
  - Gaviota: B 150
  - Hollister: B 143
  - Jamesburg: R 40b
  - Lake Elsinore: B 146
  - Lompoc: B 150
  - Los Olivos: B 150
  - Macdoel: B 151
  - Mare Island: B 149
  - Mount Vaca: B 149
  - Nenach: B 153
  - Petaluma: B 149
  - Point Arguello: B 150
  - Point Conception: B 150
  - Point Reyes: B 149
  - Quien Sabe: B 147
  - Randsburg: B 95
  - San Benito: R 39b
  - San Juan Bautista: B 133
  - Santa Rosa: B 149
  - Sonoma: B 149
  - Tesla: B 140
  - Vacaville: B 149
- MAPS, MINERAL, copper: B 23; 50
  - see also: Maps, economic mineral series
- MAPS, MINES AND MINERAL DEPOSITS
  - Alameda County: J 46b
  - Amador County: RM 12
  - Butte County: RM 17; J 45c
  - Calaveras County: RM 1
  - El Dorado County, western: RM 6; R 34c
  - Imperial County: R 38b
  - Inyo County: RM 7; R 34d; J 47a
  - Kern County: RM 18; J 45b
  - Lake County: RM 8; J 43a
  - Los Angeles County: R 33c
  - Madera County: J 46d
  - Mariposa County: RM 19
    - gold mines: R 31a
  - Mono County: R 36b
  - Nevada County: RM 5
  - Placer County: RM 9
  - Plumas County: RM 2; R 33b
  - Riverside County: R 41c
  - San Bernardino County: RM 11; R 26c; 39d
  - San Diego County: RM 14; R 35a
  - Santa Barbara County: RM 20

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- MAPS, MINES AND MINERAL DEPOSITS—Continued
  - Shasta County: RM 10; R 35b
  - Sierra County: RM 15
  - Siskiyou County: RM 3; R 31c; J 43d
  - Sonoma County: J 46a
  - Stanislaus County: J 43b
  - Tehama County: R 42c
  - Trinity County: RM 4; R 37a
  - Tuolumne County: RM 16; J 45a
  - Yolo County: J 46c
  - Yuba County: RM 21
  - See also: Maps, geologic quadrangle series
- MAPS, MINING CLAIM, Grass Valley district: R 37c
  - Mother Lode belt in Amador, Calaveras, El Dorado, and Mariposa Counties: B 108
  - Nevada City district: R 37c
  - Nevada County, western: R 37c
- MAPS, NATIONAL FOREST, El Dorado County: M 12
  - Madera County: M 5
  - Placer County: M 6
  - Shasta County: M 7
  - Sierra County: M 8
  - Siskiyou County: M 9
  - Trinity County: M 10
  - Tuolumne County: M 11
- MAPS, OIL FIELD, California: B 118c
  - Los Angeles City: RM 13
  - Oil City fields, Fresno County: B 15
- MAPS, TOPOGRAPHIC, COUNTY
  - Del Norte: B 134 a1
  - Siskiyou: B 134 a2
- MAPS, TOPOGRAPHIC QUADRANGLE: see Maps, geologic quadrangle series
- Mare Island quadrangle, geology of: B 149
- MARIN COUNTY
  - Mare Island quadrangle, geology of: B 149
  - MINES AND MINERAL RESOURCES: R 8; 10; 11; 14b; 17; 22c
  - Petaluma quadrangle, geology of: B 149
  - Point Reyes quadrangle, geology of: B 149
- MARIPOSA COUNTY
  - American Eagle-Blue Moon zinc deposits: B 144
  - chromite: B 134 c1
  - geology: R 12
  - La Victoria copper mine: B 144
  - MINES AND MINERAL RESOURCES: RM 19; R 8; 10; 14d; 17; 24b
- MARKETS, MARKETING: see Mineral economics
- Marysville Buttes gas field: R 39c; B 118c
- Mayacmas district, quicksilver deposits: R 42c
- McDonald Island gas field: B 118c
- McKittrick oil field: RM 18; B 118c
- Meadow Lake district, Nevada County, gold veins: R 32b
- MENDOCINO COUNTY, carbon-dioxide gas: R 39c
  - geology: R 10
  - MINES AND MINERAL RESOURCES: R 8; 10; 11; 14c; 17; 19d; 25d
- Mendota Canal, Delta-, geology of: SR 2
- MERCED COUNTY
  - MINES AND MINERAL RESOURCES: R 8; 10; 11; 14d; 17; 21d
  - Quien Sabe quadrangle, geology of: B 147
  - Stayton district, quicksilver and antimony in: B 147
- Mercury: see Quicksilver

Note: Please do not order from finding lists; refer to text to see whether publication is still in stock. Out-of-print publications can no longer be obtained from the Division of Mines.

- Mesozoic, in California : B 118b
- Metallurgical works, need for : R 1
- METALLURGY AND ORE-DRESSING, Belmont Shawmut mine, Tuolumne County : R 18*l*
  - chlorination : R 6b
  - complex ores : B 144
  - concentration of gold and silver ores : R 6b
  - condenser installation at New Idria Quicksilver Mining Co. : J 43a
  - cyanide process : R 10 ; 27b ; 34c ; B 5
  - hydrometallurgy of gold : R 8
  - hydrometallurgy of silver : R 8
  - milling of gold quartz : R 2 ; 6 ; 8 ; B 6
  - Penn mine slag dump : J 45a
  - platinum : R 18d
  - quicksilver : B 78
  - Russell process, lead-silver ores : R 8
  - smelting of lead ores : R 8 ; 10
  - treatment of flour gold : R 2
  - use of producer-gas as fuel : R 10
- Meteorites : R 10
  - Goose Lake : R 35c
- Meteorological observations : R 9
- Mica : R 2 ; 40d ; B 156-3
  - see also : Vermiculite
- Midway quadrangle, Delta-Mendota Canal in : SR 2
- Midway-Sunset oil field : PR 2 ; RM 18 ; B 118c
- Milling : see Metallurgy and ore dressing
- Millspaugh iron desposit, Inyo County : R 42d
- Minarets district, Madera County : R 22d ; B 129i
- Mineral commodities, California : B 156
- MINERAL ECONOMICS : B 130 ; 156
  - chemicals, northern California markets for : J 46c
  - costs of mining and concentrating chromite : R 36b
  - costs of trucking and packing gold ore : R 35c
  - economic aspects of of mercury production : J 44d
  - industrial uses of limestone and dolomite : J 45b
  - manganese : B 125
  - marketing commercial minerals : B 87
  - marketing complex ores : B 144
  - marketing magnesite : R 40a
  - marketing talc, pyrophyllite, and ground soapstone : R 37b
  - marketing vermiculite : R 40d
  - new use for quicksilver : R 41b
  - oil and gas industry : B 118a
  - price of gold : R 37c
  - problems of mineral industry : 36d
  - prospect for minor metals and nonmetallics : R 35a
  - pulp and paper industry, chemicals used in : J 45c
  - roofing granules : J 45c
  - rubber industry, minerals used in : J 45d
  - specifications and prices for manganese and chrome : R 37d
  - see also under individual minerals, and Mining law
- Mineral industry in California, progress 1896-99 : B 20
- Mineral paint deposits, California : R 26b
- Mineral pigment tests : R 25a
- Mineral production of California : see Statistics, California mineral production
- Mineral springs : see Springs, mineral
- Mineral utilization, age of : R 32c
- Minerals, California : see California, minerals of
- Minerals, strategic : see strategic minerals

Note: Please do not order from finding lists; refer to text to see whether publication is still in stock. Out-of-print publications can no longer be obtained from the Division of Mines.

- MINING, development of prospect into mine: R 32b
  - drainage in: R 6b; B 9
  - exploitation of small mines and prospects: R 18b
  - glossary of terms used in: R 2
  - measuring ore bodies: R 13
  - methods and costs at Lava Cap Gold Mining Corp.: R 37c
  - methods of timbering: B 2
  - oil sands: R 18f
  - preservation of timbers: R 13
  - sampling ore bodies: R 13
  - use of compressed air in: R 13
  - use of electricity in: R 12; 13
  - valuation of properties: R 18h
  - see also under particular minerals
- MINING LAW: R 6b; 7; 21a; 29b; 31c; 39c; 41c; B 66; 70; 71; 130
  - acquiring mining claims through tax title: R 28c
  - Act defining hydraulic mining: R 12
  - Act establishing mine-bell signals: R 12
  - Act for development and control of atomic energy: J 45b
  - Act regulating mineral, oil and gas brokers and salesmen: R 40d
  - agricultural minerals act: R 19d
  - Alien Act amendment: R 8
  - AMERICAN: R 11 24c; B 75; 98; 123
  - assessment work: R 18e; 25c; 26b; 29a; 30c; 32c; 35c; 38b; 40d
  - CALIFORNIA: R 24c; 37c; J 44a; 46b; B 56; 60; 66; 70; 71; 75; 106; 120; 127; 138
  - Caminetti Act: R 12; 34c; B 135
  - Death Valley National Monument open to mining: R 30c
  - Debris Commission Act: R 12
  - debris control: R 33b
  - definition of gas, gasoline and petroleum: R 22c
  - definition of hydraulic mining: B 135
  - Eagle Bird mine suit: R 10
  - Federal revenue act: R 22b
  - fish and game districts: R 27c; B 135
  - grubstake permits: R 31b
  - in recent years: J 44c; 45c; 46d
  - Joshua Tree National Monument: R 32c
  - lands open to mining: R 20c; 24c
  - leasing system applied to metal mining: R 31c
  - legislative control in mineral industry: B 130
  - license requirements: R 20c
  - licensing of gold and silver dealers: R 21c
  - location of claims: R 10; see also mining law, California
  - location on stock-raising lands: R 19b
  - mine financing: R 31c
  - mine taxation: R 35b
  - mineral patents: J 43a
  - mining claims on public domain: J 43a
  - needed changes in statutory and administrative law: B 130
  - oil and gas rights: R 20b,c,d
  - Ore Buyers' License Act: R 23c; 25c
  - power permits on navigable streams: R 37a
  - Reconstruction Finance Corp. loans: R 31a
  - relocation of claims: R 42a
  - Securities Act of 1933: R 37a
  - State Lands Act: R 34c
  - Strategic Minerals Act: R 35c
  - surface rights in national forests: R 25c
  - tariff on nonmetallics: R 27a; 28a
  - tax exemptions and loans for strategic minerals: R 36d

Note: Please do not order from finding lists; refer to text to see whether publication is still in stock. Out-of-print publications can no longer be obtained from the Division of Mines.

MINING LAW—Continued
- U. S. Patents in California: R 8
- water rights: R 8

Miocene, correlation of formations in California: B 118b
MODOC COUNTY, MINES AND MINERAL RESOURCES: R 8; 10; 15b; 17; 25a; 32d
Mojave Desert, geology of dry placers: R 30c
- map showing mountains of: RM 11

Mojave mining district, mining activity in: R 31d
Molybdenum: PR 4; B 156-4
- new methods for determination of: R 39a

MONO COUNTY, geology: R 8; 26d; 30a
- MINES AND MINERAL RESOURCES: R 8; 10; 12; 15a; 17; 18i; 23d; 36b

MONO COUNTY, SOUTHWESTERN, geology and mineral deposits: R 30a
Mono Craters tunnel, formations encountered in driving: R 36b
Montebello oil field: B 118c
Monterey Bay, sediments of: R 28a
MONTEREY COUNTY, building stone from Carmel Valley: R 28a
- geology: R 12
- Hollister quadrangle, geology of: B 143
- MINES AND MINERAL RESOURCES: R 8; 10; 11; 15e; 17; 21a; 31d
- phosphorite from Carmel Valley: R 40d

Moody Gulch oil field: B 118c
Mother Lode, geology of: R 10; 13; 28c; B 18; 108; 141
Mount Diablo region, geology and oil possibilities: B 118c
Mount St. Helena, geology: R 6a
Mount Vaca quadrangle, geology of: B 149
Mountain Copper Co., Ltd., The, cyanide treatment of gossan: R 27b; 34c
- fifty years of operation in Shasta County: J 43b

Mountain View oil field: B 118c
Mud volcanoes, in Colorado Desert: R 2
Mylonites, in eastern San Gabriel Mountains: R 39b

NAPA COUNTY, geology: R 11
- Knoxville district quicksilver deposits: R 41b
- Mayacmas district quicksilver deposits: R 42c
- MINES AND MINERAL RESOURCES: R 8; 10; 14b; 17; 25b; J 44b
- Mount Vaca quadrangle, geology of: B 149
- Oakville district quicksilver deposits: J 45a
- Santa Rosa quadrangle, geology of: B 149
- Sonoma quadrangle, geology of: B 149

Natural gas
- California: R 7; 12; 13; B 3; 11; 19; 73; 82; 84; 118a; 156-2
- Summerland, Santa Barbara County: R 10

Natural gasoline, California: B 156-2
Needles magnesite deposit, San Bernardino County: J 46c
Needles-Goffs region, San Bernardino County, geology of: R 40a
Nevada, borax in: R 3, pt. 2
NEVADA COUNTY, gold veins of Meadow Lake district: R 32b
- MINES AND MINERAL RESOURCES: RM 5; R 6b; 8; 10; 11; 16a; 17; 20d; 26b; 37c

New Idria district quicksilver deposits: R 39a; 42b
New Idria Quicksilver Mining Co., condenser installation at: J 43a
New Orleans World's Industrial and Cotton Centennial Exposition, 1884-85, California participation in: R 5
Newberry Mountains, geology and mineral deposits: R 36c
Newhall oil field: B 118c
Newport oil field: B 118c
Newton copper mine, Amador County: B 144
Nickel: PR 5
- history of the name: R 37c
- deposits, Julian-Cuyamaca area, San Diego County: R 42a

Note: Please do not order from finding lists; refer to text to see whether publication is still in stock. Out-of-print publications can no longer be obtained from the Division of Mines.

Nitrogen compounds: B 156-3
Nopah region, Paleozoic section in: R 33d
North Star Mining Co., transmission plant for: R 13

Oakville district, Napa County, quicksilver in: J 45a
Oil: see also Petroleum
Oil properties, valuation of: R 18h
Oil sands, mining: R 18f
Oil shale, Santa Barbara County: R 19d
Old Dad Mountain iron-ore deposit, San Bernardino County: B 129d
Oligocene, sequence of formations in California: B 118b
ORANGE COUNTY, clay deposits: R 31a
  geology: R 11; 17
  Lake Elsinore quadrangle, geology of: B 146
  MINES AND MINERAL RESOURCES: R 10; 15d; 21a
Orcutt (Santa Maria) oil field: B 118c
Ord Mountains, geology and mineral deposits: R 36c
Ore-dressing: see Metallurgy and ore-dressing

Pacific Coast Mineral Exposition: R 3 pt. 1; 4
Pacific slope, ethnology and geology: R 2
PALEONTOLOGY, catalogue of California fossils: R 7; B 4
  characteristic fossils of California: B 118b
  diatoms: R 18b
    from Kreyenhagen shale: R 27b
  foraminifera, California: B 118b
    from Kreyenhagen shale: R 27b
  fossil plants from auriferous gravels, Sierra Nevada: R 28c
  mammoth tusks: R 25a
  silicoflagellates, from Kreyenhagen shale: R 27b
Paleozoic section, Nopah and Resting Springs region: R 33d
Palm Springs-Blythe strip, geology of: R 40a
Panamint Range, geology and mineral resources: R 28c
Paper industry, western: J 45c
Paskenta region, geology and oil possibilities: B 118c
Peat deposits, California: R 18c; B 156-2
Pebbles, grinding: B 156-3
Peninsular Range, geologic section across southern: R 31b
Penn zinc-copper mine, Calaveras County: J 45a; B 144
Perlite: J 44c; B 156-3
Perlite deposits, Sonoma County: J 46a
Perris block, geology and mineral resources: R 31d
Petaluma quadrangle, geology of: B 149
Petaluma region, geology and oil possibilities: B 118c
PETROLEUM: R 7; 13
  analysis of California: B 31
  Caliente Range, Cuyama Valley, Carrizo Plain: R 35c
  damage by water in fields: PR 1, 2
  genesis of California: B 16
  CALIFORNIA: R 7; 12; 13; 34a; B 3; 11; 19; 63; 69; 73; 82; 84; 89; 118
  Oil City fields, Fresno County, map of: B 15
  production and use of California: B 32; 156-2
  Pico Canyon oil field: R 10
  Placerita field, Los Angeles County: J 46a
  Register of wells, Los Angeles City: RM 13
  San Diego County, southwestern: R 35a
  San Jose Hills, western: J 46b
  unproved areas in California: B 89
  water-flooding in California fields: J 45b,c,d
  see also: Oil
Petroleum gases, liquefied: B 156-2

Note: Please do not order from finding lists; refer to text to see whether publication is still in stock. Out-of-print publications can no longer be obtained from the Division of Mines.

Phosphates: B 156-3
Phosphorite deposits
  Carmel Valley: R 40d
  submarine: J 46a
Pico Canyon oil field: R 10
Piedmontite, discovery in Sierra Nevada: R 29a
Pine Creek tungsten mine, Inyo County: R 41d
Pioneer copper mine, El Dorado County: B 144
Piru oil field: B 118c
PLACER COUNTY, Duncan Canyon region, ancient channels in: R 21c
  gold mines: R 32a
  MINES AND MINERAL RESOURCES: RM 9; R 8; 10; 11; 15c; 17; 23c
Placer deposits: see Gold, geology of placer
Placerita oil field, Los Angeles County, geology: J 46a
Placers, new technique applicable to study of: R 31b
Platinum: R 1
  DEPOSITS, California: B 85
  machines for recovery of: R 25a
  metallurgy of: R 18d
Platinum metals: B 156-4
Playa del Rey oil field: B 118c
Pleistocene, correlation of formations in California: B 118b
Pliocene, correlation of formations in California: B 118b
PLUMAS COUNTY, current mining activity: R 39a
  MINES AND MINERAL RESOURCES: RM 2; R 8; 10; 11; 16b; 17; 24d; 33b
Point Arena-Fort Ross region, geology and oil possibilities: B 118c
Point Arguello quadrangle, geology of: B 150
Point Conception quadrangle, geology of: B 150
Point Reyes quadrangle, geology of: B 149
Polarograph: J 44d
Potash: PR 5
Potrero Hills gas field: B 118c
Potrero oil field: B 118c
Pottery: R 9
Practical Hydraulics, tables from: R 6b
PROSPECTING, geochemical: B 118a
  geomagnetic: R 29a
  gold and silver: R 1
  gold placer deposits: B 135
Public Resources Code, California: B 130; J 44d
Pulp and paper industry, western: J 45c
Pumice: J 43d; 44c; B 156-3
Pumicite: B 156-3
Pyrites: B 156-3
Pyrophyllite: B 156-3
  marketing of: R 37b
  San Dieguito area, San Diego County: SR 4

Quadrangles, geologic: see Maps, geologic quadrangle series
Quail Hill copper area, Calaveras County: B 144
Quartz: R 37c
Quartz crystal: B 156-3
  geology of mines near Mokelumne Hill: R 40d
  specifications for: R 24c
QUICKSILVER: B 156-4
  economic aspects of production: J 44d
  exploration program of U. S. Geological Survey: R 37d
  geology of deposits: R 33a
  statistics on mining and production: R 10; 32c
  use in batteries: R 41b

Note: Please do not order from finding lists; refer to text to see whether publication is still in stock. Out-of-print publications can no longer be obtained from the Division of Mines.

QUICKSILVER DEPOSITS, California : M 18 ; R 1 ; 12 ; 13 ; 35d ; B 27 ; 78
  Altoona mines, Trinity County : J 46c
  Cachuma district, Santa Barbara County : J 46d
  central San Benito and northwestern Fresno Counties : R 41a
  Coso Range, Inyo County : R 26a ; 38c
  Guerneville district : J 44c
  Knoxville district : R 41b
  Mayacmas district : R 42c
  New Idria district : R 39a ; 42b
  Oakville district, Napa County : J 45a
  Skaggs Springs mine, Sonoma County : J 46c
  Stayton district, San Benito, Santa Clara, and Merced Counties : B 147
  Sulphur Bank mine, Lake County : R 42b
  Walibu mine, Kern County : J 43a
Quien Sabe quadrangle, geology of : B 147

Radioactivity, at The Geysers : R 18j
Randsburg quadrangle, geology and ore deposits : B 95
Rare-earth elements : B 156-4
Red Mountain magnesite district : J 46b
Red Rock mining district, Kern County : R 12
Redding field district, mines and mineral resources : R 17 ; 19 ; 39a,c ; J 44d
Redding quadrangle, geology and gold deposits : R 29a
Refining, precious metals : R 9
Republic area, Midway-Sunset oil field : B 118c
Resting Springs region, Inyo County, geology and mineral resources : R 33d
Richfield oil field : B 118c
Rincon Hill well, San Francisco : R 10
Rincon oil field : B 118c
Rio Bravo oil field : B 118c
Rio Vista gas field : B 118c
RIVERSIDE COUNTY, clay deposits : R 19d ; 31a
  Crestmore minerals : R 39c
  Eagle Mountains iron-ore deposit : B 129a
  geology : R 40a ; 42a
  Jurupa Mountains, geology : SR 5
  Lake Elsinore quadrangle, geology of : B 146
  MINES AND MINERAL RESOURCES : R 15d ; 17 ; 20c ; 25d ; 41c
  Perris block : R 31d
Roofing granules, economics : J 45c
Roscoelite : R 2
Round Mountain oil field : B 118c
Rubber industry, minerals used in : J 45d
Rumsey Hills area, geology and oil possibilities : B 118c

SACRAMENTO COUNTY
  Antioch quadrangle, geology of : B 149
  MINES AND MINERAL RESOURCES : R 8 ; 10 ; 11 ; 15c ; 17 ; 21a
Sacramento field district, strategic minerals in : R 39a,b,c,d
Sacramento Valley, basement complex : J 44b
Sacramento Valley, northern, Tertiary formations of : R 35c
Safety work, U. S. Bureau of Mines : J 46c
Saline deposits, California : M 15 ; B 24
  Searles Lake : R 41d
  see also : Salt, Borax
Salines : B 156-3
Salt : R 1 ; 2 ; 42d
  see also : Salines
Salt Lake oil field : B 118c
Saltcake, in California : J 44b

Note: Please do not order from finding lists; refer to text to see whether publication is still in stock. Out-of-print publications can no longer be obtained from the Division of Mines.

- Sampling, gold placer deposits: B 135
  - gold quartz deposits: R 30a
  - in mine examinations: R 13
- SAN BENITO COUNTY, geology: R 12
  - Granite Rock Co. operations: B 133
  - Hollister quadrangle, geology of: B 143
  - MINES AND MINERAL RESOURCES: R 8; 10; 11; 15e; 17; 18e; 22b; J 43a
  - New Idria district quicksilver deposits: R 39a; 42b
  - Quien Sabe quadrangle, geology of: B 147
  - Stayton district, quicksilver and antimony in: B 147
- SAN BENITO COUNTY, CENTRAL, quicksilver deposits of: R 41a
- San Benito quadrangle, geology: R 39b
- SAN BERNARDINO COUNTY, Chino area, oil possibilities: B 118c
  - geology: R 8; 11; 40a
    - Newberry and Ord Mountains: R 36c
  - iron deposits: R 42d; B 129b,c,d,e,f,g,h,m
  - Jurupa Mountains, geology: SR 5
  - MINES AND MINERAL RESOURCES: RM 11; R 8; 9; 10; 11; 15f; 17; 19d; 26c; 27c; 39d
- SAN DIEGO COUNTY
  - dimension stone, granitoid: SR 3
  - geology: R 8; 11; 35a
  - ironstone concretions and beach ridges in: J 46b
  - Julian district, mines and mineral resources: R 30c
  - Julian—Cuyamaca area, geology: R 42a
  - Lake Elsinore quadrangle, geology of: B 146
  - MINES AND MINERAL RESOURCES: RM 14; R 6a; 8; 9; 10; 11; 14e; 17; 20d; 21c; 35a
  - oil and gas possibilities: B 118c
  - San Dieguito pyrophyllite area: SR 4
- San Dieguito pyrophyllite area, San Diego County: SR 4
- San Francisco Bay, geology of area north of: B 149
- SAN FRANCISCO COUNTY, auriferous beach sands: R 10
  - MINES AND MINERAL RESOURCES: R 8; 17; 25b
- San Francisco field district, mines and mineral resources: R 17; 19; 31a; 39a
- San Gabriel Mountains, eastern, mylonites in: R 39b
- San Gabriel Mountains, western, geology and mineral deposits: R 33c
  - titaniferous iron-ore deposits of: B 129p
- San Jacinto quadrangle, geology south of San Gorgonio Pass: R 27d
  - mineral deposits of: R 28a
- SAN JOAQUIN COUNTY, MINES AND MINERAL RESOURCES: R 8; 10; 11; 14d; 17; 21b
  - Tesla quadrangle, geology of: B 140
- San Joaquin Valley, basement complex: J 44b
  - oil-producing zones of: B 118b,c
- San Jose Hills, geology and oil prospects: J 46b
- San Juan Bautista quadrangle, geology: B 133
- SAN LUIS OBISPO COUNTY, chromite deposits: R 39a
  - concretions from Templeton: J 44c
  - geology: R 12
  - MINES AND MINERAL RESOURCES: R 8; 10; 15e; 17; 21d; 31d
- SAN MATEO COUNTY
  - Calera limestone in: SR 1B
  - manganese discovery in: R 39b
  - MINES AND MINERAL RESOURCES: R 8; 10; 17; 25b
- San Miguel Island: see Channel Islands
- San Nicolas Island, geology: R 9
- Sanbornite: R 28a
- Sand: B 156-3
- Sands: see Foundry sands

Note: Please do not order from finding lists; refer to text to see whether publication is still in stock. Out-of-print publications can no longer be obtained from the Division of Mines.

Santa Ana Mountains, Cretaceous formations of: B 118b
SANTA BARBARA COUNTY
  Cachuma quicksilver district: J 46d
  Gaviota quadrangle, geology of: B 150
  geology of: R 12
  Lompoc diatomite deposits: R 32b
  Lompoc quadrangle, geology of: B 150
  Los Olivos quadrangle, geology of: B 150
  MINES AND MINERAL RESOURCES: RM 20; R 8; 10; 15e; 17; 21d
  oil and gas yielding formations in: B 11
  oil shale in: R 19d
  Point Arguello quadrangle, geology of: B 150
  Point Conception quadrangle, geology of: B 150
  Sierra Blanca limestone in: SR 1A
Santa Barbara County, southwestern, geology of: B 150
Santa Catalina Island, mines and mineral resources: R 23a
SANTA CLARA COUNTY
  Calera limestone in: SR 1B
  Hollister quadrangle, geology of: B 143
  MINES AND MINERAL RESOURCES: R 8; 9; 10; 11; 17; 26a
  Quien Sabe quadrangle, geology of: B 147
  Red Mountain magnesite district: J 46b
  Stayton district, quicksilver and antimony in: B 147
SANTA CRUZ COUNTY, MINES AND MINERAL RESOURCES: R 8; 10; 17; 22a; 39a
Santa Cruz Island, geology: R 9; 27b
  see also: Channel Islands
Santa Fe Springs oil field: B 118c
Santa Maria district, oil-producing zones of: B 118b
Santa Maria oil field: RM 20; B 118c
Santa Maria River, ground-water geology: R 10
Santa Maria Valley oil field: B 118c
Santa Monica Mountains, central, geology of: R 34b
Santa Paula oil field: B 118c
Santa Rosa Island: see Channel Islands
Santa Rosa Mountain area, Riverside County, geology: R 42a
Santa Rosa quadrangle, geology of: B 149
Sargent oil field: B 118c
Scheelite, fluorescence of: R 37d
  molybdenum in: R 39a
  occurrence in Idaho-Maryland mine: R 37b
  prospecting for: R 34c
  see also: Tungsten
Seal Beach oil field: B 118c
Sediments, Monterey Bay: R 28a
Semitropic gas field: B 118c
Sespe oil field: B 118c
Shasta and California iron-ore deposits, Shasta County: B 129k
SHASTA COUNTY, copper deposits: R 20d
  geology: R 11
  gold dredging in: R 34b
  Hirz Mountain iron-ore deposits: B 129j
  limestone deposits on McCloud River: R 18b
  MINES AND MINERAL RESOURCES: RM 10; R 8; 10; 11; 14f; 17; 18i; 22b; 35b
  Shasta and California iron-ore deposits: B 129k
  South Fork mining district, gold lodes: R 18g
Shasta quadrangle, economic geology of: R 27a
Shells, catalogue of west North American and foreign: SP 8
Shiells Canyon area, Bardsdale oil field: B 118c
Ship Mountains iron-ore deposit, San Bernardino County: B 129h
Sierra Blanca limestone, Santa Barbara County: SR 1A

Note: Please do not order from finding lists; refer to text to see whether publication is still in stock. Out-of-print publications can no longer be obtained from the Division of Mines.

- SIERRA COUNTY, Alleghany district, quartz mining in: R 18j
  - iron-ore deposits near Lake Hawley and Spencer Lakes: B 129l
  - MINES AND MINERAL RESOURCES: RM 15; R 6b; 8; 10; 11; 16c; 17; 20d; 25b; 38a
- SIERRA NEVADA, genesis and metamorphism of manganese deposits: B 125
  - geology and tungsten deposits northeast of Visalia: R 39b
  - geomorphic province: B 141
- SIERRA NEVADA, NORTHERN, geology: R 28c
- Sierra Nevada province, chromite in: B 134c
- Sierran gold belt, guidebook to: B 141
- Silica, opaline, industrial applications: R 32d
- Silica deposits, California: R 27c
  - see also: Foundry sands
- Sillimanite: R 39c; B 156-3
- Silver: J 43d; B 156-4
  - refining and coining: R 9
- Silver deposits, California: R 9; 12; 13
  - Calistoga mines: R 6a
  - South Fork mining district, Shasta County: R 18g
  - see also: Galena, argentiferous
- Silver Lake district, San Bernardino County, iron deposits: B 129c
- Simi oil field: B 118c
- SISKIYOU COUNTY, chromite deposits: R 39a; B 134 a2
  - circular soil structures: B 151
  - dragline dredging in: R 37b
  - Gazelle region, geology of limestone deposits in: J 45d
  - gold dredging in: R 34b
  - Macdoel quadrangle, geology: B 151
  - MINES AND MINERAL RESOURCES: RM 3; R8; 10; 11; 14f; 17; 21d; 31c; J 43d
- Sites region, geology and oil possibilities: B 118c
- Skaggs Springs quicksilver mine, Sonoma County: J 46c
- Slate: B 156-3
  - quarrying: R 9
- Smelting: see Metallurgy and ore-dressing
- Soapstone, marketing: R 37b; B 156-3
- Soda ash, in California: J 44b
- SOLANO COUNTY
  - Antioch quadrangle, geology of: B 149
  - Carquinez quadrangle, geology of: B 149
  - Mare Island quadrangle, geology of: B 149
  - MINES AND MINERAL RESOURCES: R 8; 10; 14b; 17; 23b
  - Mount Vaca quadrangle, geology of: B 149
  - Vacaville quadrangle, geology of: B 149
- Soledad quadrangle, geology and oil possibilities: B 118c
- SONOMA COUNTY, Guerneville district quicksilver deposits: J 44c
  - Mare Island quadrangle, geology of: B 149
  - Mayacmas district quicksilver deposits: R 42c
  - MINES AND MINERAL RESOURCES: R 8; 10; 11; 14b; 17; 22c; J 46a
  - Perlite deposits: J 46a
  - Petaluma quadrangle, geology of: B 149
  - Point Reyes quadrangle, geology of: B 149
  - Santa Rosa quadrangle, geology of: B 149
  - Skaggs Springs quicksilver mine: J 46c
  - Sonoma quadrangle, geology of: B 149
  - The Geysers: R 18j; 42c
- SONOMA COUNTY, NORTHERN, carbon-dioxide gas in: R 39c
- Sonoma quadrangle, geology of: B 149
- Sonora region, Tuolumne County, limestone in: J 45d
- South Fork mining district, Shasta County, silver lodes: R 18g
- South Mountain oil field: B 118c

Note: Please do not order from finding lists; refer to text to see whether publication is still in stock. Out-of-print publications can no longer be obtained from the Division of Mines.

Spectrograph : J 44d
Spencer Lakes iron-ore deposits, Sierra County : B 129l
Springs, desert fissure, in San Bernardino County : RM 11
Springs, mineral, California : R 6a ; 12 ; 13
Stanford University Geological Survey, map of part of Foothill copper belt by : R 39d
STANISLAUS COUNTY
  Copperopolis quadrangle, geology of : B 145
  MINES AND MINERAL RESOURCES : R 8 ; 10 ; 11 ; 14d ; 17 ; 21b ; J 43b
  Red Mountain magnesite district : J 46b
State geological surveys : J 45b
  Mineralogist, Annual Report of : J 43d ; 45a ; 46a ; 47b
    Biennial Report of : SP 14 ; 15 ; 16 ; 17 ; 18 ; R 24d ; 26d ; 28c ; 30c ; 32d ; 34 ; 36d ; 38c ; 40d ; 42c
STATISTICS, CALIFORNIA MINERAL PRODUCTION : M 3 ; SP 19 ; R 6b ; 18j ; J 47b ; B 7 ; 8 ; 12 ; 13 ; 14 ; 17 ; 21 ; 22 ; 25 ; 26 ; 28 ; 29 ; 33 ; 34 ; 39 ; 40 ; 42 ; 43 ; 47 ; 48 ; 51 ; 52 ; 53 ; 54 ; 55 ; 56 ; 58 ; 59 ; 60 ; 61 ; 62 ; 64 ; 65 ; 68 ; 70 ; 71 ; 74 ; 83 ; 86 ; 88 ; 90 ; 93 ; 94 ; 96 ; 97 ; 100 ; 101 ; 102 ; 103 ; 105 ; 107 ; 109 ; 110 ; 111 ; 112 ; 114 ; 116 ; 117 ; 119 ; 121 ; 122 ; 126 ; 128 ; 130 ; 132 ; 137 ; 139 ; 142 ; 156
  oil and gas : B 118a
  quicksilver : R 10
  see also : California, mines and minerals of
STATISTICS, U.S. MINERAL PRODUCTION : R 6b ; 7 ; 9
Stayton district, quicksilver and antimony in : B 147
Stone : B 156-3
Strand oil field : B 118c
Strategic minerals : R 34c ; 36a,d ; 37a ; 39a ; 41a
  in Sacramento field district : R 39a,b,c,d
  U.S. Geological Survey publications on : R 39a
Stream deposits, glacial, Sierra Nevada : R 28c
Strontium : PR 5 ; B 156-3
Structural materials : see Building materials
Submarine phosphorite, off California coast : J 46a
SUBMARINE TOPOGRAPHY, canyons off California coast : R 34c
  Monterey Bay : R 28a
Sulfur : B 156-3
  deposits, Inyo County : R 34d
Sulfuric acid : B 156-3
Sulphur Bank quicksilver mine, Lake County : R 42b
Summerland, natural-gas well at : R 10
Summerland oil field : RM 20 ; B 118c
Summit mining district, Kern County : R 12
Sutter Buttes gas field : see Marysville Buttes gas field
SUTTER COUNTY, Marysville Buttes gas field : R 39c ; B 118c
  MINES AND MINERAL RESOURCES : R 8 ; 10 ; 11 ; 15b ; 17

Talc : R 27a ; B 156-3
  marketing of : R 37b
TEHAMA COUNTY, geology : R 11 ;
  MINES AND MINERAL RESOURCES : R 8 ; 10 ; 11 ; 15b ; 17 ; 24c ; 42c
  North Elder Creek area chromite deposits : R 39a
Tejon formation, type locality of the : B 118c
Temblor oil field : B 118c
Ten Section oil field : B 118c
Tertiary, correlation of California : B 118b
  channels : see Gold, geology of placer
  formations, northern Sacramento Valley : R 35c
Tesla quadrangle, geology of : B 140
Thorium : B 156-4
Tiefort Mountains iron deposit, San Bernardino County : R 42d
Timber, preservation of : R 13

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Tin: PR 5; R 1; B 156-4
  deposits, California: R 37d
    Gorman district, Kern County: R 42a
Titaniferous iron-ore deposits, Los Angeles County: B 129p
Titanium: B 156-4
Topanga Canyon quadrangle, geology: R 34b
Topographic mapping, program for California: R 28a
  status in California: R 40b
  status in United States: J 43c
Topographic quadrangles, index to California: R 41d
Topography, submarine: see Submarine topography
Torrance oil field: B 118c
Township and range system, California, index to: B 118b
Tracy gas field: B 118c
Tracy region, Delta-Mendota Canal: SR 2
Trico gas field: B 118c
TRINITY COUNTY
  Altoona quicksilver mine: J 46c
  Clerbus-Mae tungsten prospect: R 39b
  East Fork mining district, gold lodes: R 18f
  gold dredging in: R 34b
  MINES AND MINERAL RESOURCES: RM 4; R 8; 10; 11; 14f; 17; 22a; 37a
Trustees of the State Mining Bureau, reports of: SP 10; 13; 14; 15; 16; 17; R 6b; 7; 8; 9; 10; 11; 12; 13
TULARE COUNTY, chromite deposits of: B 134c3
  MINES AND MINERAL RESOURCES: R 8; 10; 11; 15f; 17; 18j; 26d
Tungsten: PR 4; B 156-4
  see also: Scheelite
TUNGSTEN DEPOSITS
  California: R 37b,d
    tabulation to accompany map showing: R 38c
  Clerbus-Mae prospect, Trinity County: R 39b
  Confidence mining district, Tuolumne County: R 38c
  Madera County: R 38c
  Pine Creek and Adamson: R 41d
  Sierra Nevada, northeast of Visalia, Tulare County: R 39b
  Tungsten Hills, Inyo County: J 46a
Tungsten Hills, Inyo County, geology and tungsten deposits: J 46a
TUOLUMNE COUNTY, chromite: B 134 c1
  Confidence mining district, tungsten deposits: R 38c
  Copperopolis quadrangle, geology of: B 145
  MINES AND MINERAL RESOURCES: RM 16; R 6b; 8; 10; 11; 14a; 17; 24a; J 45a
  Sonora region, geology of limestone deposits in: J 45d
Twenty-five Hill area, Midway-Sunset oil field: B 118c
Twin Lakes region, Fresno County, contact-metamorphic rocks: R 38c

Ultra-violet light, use in prospecting for scheelite: R 34c
Uranium: J 44a,d; B 156-4
U.S. Atomic Energy Commission: J 44d
U.S. Bureau of Mines
  health and safety work of: J 46c
  strategic minerals investigations: R 36a; B 129o
U.S. Geological Survey, Map Information Office: R 42d; J 43c
  map symbols used in publications of the: J 45a
  maps compiled from work of: RM 12; 15; 16; 19; 21
  publications on strategic minerals: R 39a
  quicksilver program of the: R 37d
U.S. Naval Petroleum Reserve No. 1 (Elk Hills oil field): B 118c

---

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Vacaville quadrangle, geology of: B 149
Vanadium: PR 4; J 43b
Vaqueros formation, type locality of the: B 118c
Ventura Avenue oil field: B 118c
VENTURA COUNTY, asphaltum in: R 10
  geology: R 8; 12
  MINES AND MINERAL RESOURCES: R 8; 10; 15e; 17; 21b; 28c
  oil and gas yielding formations: B 11
Vermiculite, marketing of: R 40d
Vivianite: R 2
Vulcan iron-ore deposit, San Bernardino County: B 129f

Walibu quicksilver mine, Kern County: J 43a
Wasco oil field: B 118c
Wasson, Joseph, death of: R 3
Water, in California: R 6a; 13
  in oil fields, damage by: PR 1, 2
  see also: Ground-water; Springs
Water-flooding in California oil fields: J 45b,c,d
Water rights: see Mining law
Water supply, protection of domestic: B 135
Water wheels: R 8
Weaverville quadrangle, geology and gold deposits: R 29a
Well samples, basement complex in: J 44b
Wells, Fargo & Co.: R 6b; 7
Welsh tungsten deposits, Madera County: R 38c
West Point tunnel, Amador County, geology: J 46a
Wheeler Ridge oil field: B 118c
"White metal": R 22a; 38b
Whittier oil field: B 118c
Wildcat wells, tabulated list of: B 118c
Williams area, Midway-Sunset oil field: B 118c
Willows gas field: B 118c
Wilmington oil field: B 118c
World Fairs: R 5

YOLO COUNTY, geology: R 10
  MINES AND MINERAL RESOURCES: R 8; 10; 11; 14b; 17; J 46c
  Knoxville district, quicksilver deposits of: R 41b
Yorba Linda area, Coyote Hills oil field: B 118c
YUBA COUNTY, MINES AND MINERAL RESOURCES: RM 21; R 8; 10; 11; 15c; 17; 26c; 27c

Zinc: B 156-4
  deposits, Foothill copper belt: B 144
Zirconium: B 156-4

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